A Solar-Home Rental Business Model: Capturing Synergies from Solar Energy and Single Family Rental Properties

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Abstract. The credit market collapse and housing-led economic recession beginning in 2007-2008 have resulted in several million distressed homes in the U.S. that are in various stages of delinquency, default, and foreclosure. Over the past three to four years, a number of private equity investment pools have been buying large blocks of distressed residential properties at auction, in short sales, and otherwise, with the intention of renovating and renting them at attractive yields, and ultimately, profiting from their sale as prices rebound from recessionary levels. In the process, they are institutionalizing single family rental property management on an unprecedented state and regional scale. Market demographics and persistently tight credit conditions portend several years of sustained growth in both the demand for rentals and rental rates. Simultaneously, the installed cost of solar photovoltaic (PV) systems has declined over 50% in just the last three years. Among the major catalysts of the decline have been a glut of manufacturing capacity that was built in response to pre-recession demand; federal and state financial incentives including tax credits, rebates, and performance-based payments; and gradual gains from competition and efficiencies in balance-of-system costs. Together, these two trends offer the prospect of an integrated "solar-rental" investment strategy that will produce compelling returns while significantly boosting residential solar energy use. This paper encompasses three objectives: (1) to establish a framework for a solar-home rental business model in which rental incomes are enhanced via the sale of rooftop-generated solar electricity to the tenants of single-family properties; (2) to address several of the major operational elements of such a business, including installation and maintenance of the solar energy system, tenant billing, and management of the solar operation; and (3) to model the economics of the individual solar and rental operations, and the combined enterprise, in a number of markets, in order to identify those where the solar-rental strategy would produce attractive returns relative to the rental-only approach. Thirteen cases in twelve state markets were evaluated for their solar-home rental economics. All the markets have experienced high rates of distressed single family properties since the recession and they account for the majority of institutional "REO-to-rental" purchases. Of the case studies, five produced after-tax returns exceeding 7.50%, matching or

exceeding standalone rental yields by up to 0.19%, and over 0.40% under an expected scenario of further cost declines. As a group, these markets are characterized by high marginal electricity rates, moderate to high solar insolation, and modest to significant upfront or performance-based incentives. It is estimated that the top institutional buyers have accumulated 40,000-50,000 distressed properties since 2009 and that they are expected to purchase upwards of 100,000 additional homes over the next two years. In comparison, the national single family rental market is estimated at 16 million homes, 2 million of which were added since 2006, while the number of U.S. residences with solar panels stood at approximately 300,000 as of the end of 2012. If half of the expected portfolio of institutional single family rentals was to be solarized, it would result in a 25% increase in the stock of residential solar installations, via the "leveraging" of actions by perhaps a dozen property buyers. As solar panel prices and, especially, balance-of-system installation costs continue to decline in the face of rising electricity rates, solar energy-rentals should prove an attractive proposition to residential rental property investors and a big assist to the country's renewable energy usage.

Introduction

The Case-Shiller 20-City Home Price Index measured a 35% peak-to-trough collapse in housing prices from 2006 through 2012, with a third of the markets losing 46% - 62% of their value (Laing, 2012). Over the past several years, since the Great Recession, tens of thousands of distressed single family homes have been or are in the process of being purchased by arms of experienced property management companies and private equity funds.[1] All these investors are generally planning to renovate the homes, rent them for several years, and then cash out as prices recover over time through exit strategies including outright sales and securitizations, such as REITs. The buyers claimed in 2012 pre-tax net operating yields on the order of 7%-9% were being achieved, and they expect to make double-digit capital gains at the time of sale.[2] Prevailing tight credit conditions in the home mortgage market and household formation trends virtually assure a rising demand for rental properties and upward pressure on rents for the next several years followed by pent-up demand for home purchases once lending activity normalizes and assuming a steady economic recovery (Harvard University, 2012).

Simultaneously, the U.S. solar electricity market has experienced record growth in the past several years, due to the combined effects of federal, state, and local incentives, state-mandated renewable energy quotas, high-priced electricity in some regions, and continued declines primarily in solar panel costs and, to a lesser extent, the balance-of-system costs. The biggest driver of panel price declines has been overcapacity borne of pre-recession optimism regarding future demand. The federal investment tax credit (ITC) and accelerated depreciation allowances have given birth to an entire "tax equity"-based project financing industry for commercial- and utility-scale solar photovoltaic (PV) systems. Large, profitable corporations use the ITC and accelerated depreciation to offset income tax liabilities in their main businesses, and thereby generate double-digit returns as a result of funding, and owning, the PV projects for a period of time (Sharif, Grace, & Di Capua, 2011). Falling prices, tax credits, and other incentives, have also fueled accelerated growth in the residential solar market. In certain states, upfront rebates and production-based incentives (PBIs) have significantly defrayed system costs. Over 80,000 residential installations were completed in 2012 and as of the end of the year, there were some 300,000 residential systems nationwide (SEIA & GTM Research, 2013). Third-party-owned systems accounted for over 50% of new installations in most major markets (SEIA & GTM Research, 2013). The third-party companies offer to install systems at little or no cost to the homeowner while retaining ownership of the system and claiming any incentives. The homeowner contracts to buy the solar electricity from their roof under a long-term power purchase agreement (PPA) or equipment lease, in either case achieving a savings to their current bills (Himmelman, 2012). The third parties are, in turn, funded by tax-equity investors.

[1] (Mattson - Teig, 2012) (Whelan R. , 2012) (Whelan R. , 2011) (Yu & Kelly, 2012)
[2] (Grant, 2012) (Mattson - Teig, 2012) (Whelan R. , 2012). Recent yields have been reportedly lower, on the order of 6%-7%, due to rising home purchase prices.

Among the markets with high concentrations of distressed single family properties that have been the focus of private equity investors are regions favorable to solar energy use that have witnessed much of the recent boom in residential installations. As will be illustrated in the following sections, the combination of high-cost electricity, decreasing PV system prices, modest to generous incentives, and moderate to high solar insolation[3] can produce pre-tax cash flow yields on solar investments comparable to real estate rental returns. Even when pre-tax solar returns are nominally below rental ROIs, after accounting for accelerated depreciation for solar energy investments, the after-tax returns of a joint solar-rental operation can equal or surpass the associated values of the rental operation alone.

It is generally acknowledged that a lower cost of financing is one of the keys to broader adoption of solar energy. Given the double-digit returns that have been required by tax-equity investors, who have to date comprised a limited group of large, profitable corporations, various strategies have been proposed or are in process for creating solar funding vehicles with yields more akin to those for traditional capital market instruments. These include solar REITs, solar asset-backed securitizations, and crowd-funded investments. Solar-rentals are another potential vehicle since they hold the promise of utility-scale investments in solar energy at real estate rates of return.

Development of a framework for a "solar-home rental" business model begins with an examination of the synergies available to rental property owners who sell the electricity from rooftop PV systems to their tenants in order to generate attractive supplemental revenues from existing properties. Formulae are presented to demonstrate both: (1) a case where current solar capitalization rates ("cap rates") are comparable to rental yields on a pre-tax basis, and (2) how accelerated depreciation of the solar asset can help to enhance the after-tax returns of the combined business even when pre-tax solar yields are somewhat inferior. Overviews are then provided of the distressed single family home and rental markets, the solar energy market, including the policies and incentives that have driven much of its growth in recent years, and commonalities between the two markets. Following the overviews, a number of key operating elements are considered, including system installation and maintenance, personnel requirements for managing the solar aspects of the business, and tenant billing arrangements. The discussion then turns to a description of the economic model of a solar-home rental business, including the methodologies and assumptions used to measure the pre- and after-tax returns for both the individual solar and rental components and the combined solar-rental operation. Results of thirteen case studies from twelve geographic markets are presented and analyzed. One of two California case studies is expanded to include an algorithm for determining the optimal amount

[3] Solar insolation, or irradiation, is a measure of the amount of solar energy received per unit of surface area over a given time period. A common usage of the term is to express insolation as the number of kilowatt hours of energy per square meter per year, or $kWh/m^2/yr$.

of solar panels to install in a market with limited incentives, but high marginal electricity costs due to tiered rate structures. The conclusion reviews the major findings and themes.

Solar-Rental Synergies

In concentrated distressed property markets with favorable solar investing conditions, a number of economic and environmental synergies are attainable by adding the sale of solar electricity to the underlying rental operation of distressed single-family property investors. The following sections highlight each one.

Enhanced Returns on Investment

As will be discussed in further detail in the section on the economic model, several of the regions with high concentrations of distressed single-family homes or with growing backlogs of foreclosures expected to reach the market over the next few years offer pre-tax cap rates of 7% or greater for residential solar energy investments.[4] These compare favorably with pre-tax cap rates for distressed rentals, reported to be 7%-9% during 2012, and somewhat lower recently due to competitive pricing pressure. After-tax returns of a combined solar-rental asset would be even greater due to the accelerated depreciation of the PV system. The following examples illustrate two cases where solar power returns would be competitive with rentals: on a standalone, pre-tax basis, and on an after-tax basis as part of an integrated solar-rental operation.

Example 1: Pre-tax PV system returns are competitive. As an example of solar energy pre-tax capitalization rates that might be achieved, consider a 5kW PV system in the Riverside County region of Southern California. Assuming an installed cost of \$5.00/W, a state sales tax rate of 7.75%, and utility rebates of \$2,000/kW, the system's total cost after taxes and rebates would be \$16,937.50. Also assume annual maintenance expenses of 0.5% of the pre-tax, pre-rebate cost, or \$125 in the first year of operation. A 5 kW system in this location is expected to produce 7,632 kW during the first year and we will assume its performance degrades at a rate of 0.5%/yr. Given recent electricity rates for Riverside of approximately \$0.164/kWh, the system's output would be valued at \$1,252 in year one. Finally, suppose electricity rates are projected to increase 3.5%/yr, and to keep the example simple, maintenance expenses are expected to grow at the same rate rather than the historical CPI rate of 2.6%. The pre-tax capitalization rate of this system for a 10-yr horizon, using an assumed cost of capital of 5.00%, would be 7.53% and can be calculated as the ratio of two annuities divided by the capitalized cost of the system as follows:

[4] Capitalization rates for residential solar investments can vary significantly depending on local values for installed costs, insolation level, electricity rates, rate inflation, incentive programs, etc.

$$Cap\ Rate_S = \frac{\left[\frac{PV(growing\ electricity\ annuity)}{PV(annuity\ of\ \$1)}\right]}{Installed\ System\ Cost}$$

$$= \frac{\dfrac{\dfrac{NEV_1}{\left[r-\left((1+g)(1-d)-1\right)\right]} \times \left\{1-\left(\dfrac{(1+g)(1-d)}{1+r}\right)^n\right\}}{\dfrac{1-\left(\dfrac{1}{1+r}\right)^n}{r}}}{Installed\ System\ Cost} \qquad (E1)$$

$$= 7.53\%$$

where:

$Cap\ Rate_S = Capitalization\ Rate\ of\ Solar\ Photovoltaic\ System$

$NEV_1 = Net\ electricity\ value\ in\ the\ first\ year = \#\ kWh\ \times \frac{\$}{kWh} - \ Maintenance$

$r = cost\ of\ capital = 5.00\%,$

$g = growth\ rate\ of\ electricity\ prices\ and\ maintenance\ costs = 3.50\%,$

$d = annual\ degradation\ rate\ of\ solar\ panel\ output = 0.5\%,$

$n = 10$

Example 2: After-tax returns of a combined solar-rental operation are competitive. Even when pre-tax returns on a solar PV system are lower than corresponding rental returns, the after-tax returns on a combined solar-rental operation could still exceed those of the rental operation alone due to the accelerated depreciation treatment accorded the solar energy investment. This would be true when the accelerated solar depreciation allowances help shelter enough additional rental income in earlier years, thereby shifting the timing of tax payments and increasing after-tax returns. The following expression is a simplified representation of the condition that must hold for such an outcome:[5]

$$If\ ROI_{R+S} \geq ROI_R, then:\ \frac{ATCF_R + ATCF_S}{C_R + C_S} \geq \frac{ATCF_R}{C_R} \qquad (E2)$$

where:

$ROI_{R+S} = Return\ on\ Investment\ of\ the\ combined\ Solar\ and\ Rental\ Business$

$ROI_R = Return\ on\ Investment\ of\ the\ Rental\ Business$

$$\begin{aligned} ATCF_R &= After\ Tax\ Cash\ Flow\ of\ the\ Rental\ Business \\ &= (EBITD_R - I_R - D_R \times C_R) \times (1-t) + D_R \times C_R - PPD_R \\ &= EBITD_R \times (1-t) + D_R \times C_R \times t - (I_R \times (1-t) + PPD_R) \qquad (E2.1) \\ &= EBITD_R \times (1-t) + D_R \times C_R \times t - After\ Tax\ Debt\ Service_R \end{aligned}$$

$ATCF_S = After\ Tax\ Cash\ Flow\ of\ the\ Solar\ Electricity\ Sales$

[5] In practice, this condition would have to hold for the sum of all discounted cash flows over the horizon period of the analysis.

$$= (EBITD_S - I_S - D_S \times C_S) \times (1-t) + D_S \times C_S - PPD_S$$
$$= EBITD_S \times (1-t) + D_S \times C_S \times t - (I_S \times (1-t) + PPD_S) \qquad (E2.2)$$
$$= EBITD_S \times (1-t) + D_S \times C_S \times t - After\ Tax\ Debt\ Service_S$$

$EBITD_R = Earnings\ Before\ Interest, Taxes, and\ Depreciation\ of\ the\ Rental\ Business$
$EBITD_S = Earnings\ Before\ Interest, Taxes, and\ Depreciation\ of\ the\ Solar\ Business$
$I_R = Interest\ Payment\ on\ debt\ of\ the\ Rental\ Business$
$I_S = Interest\ Payment\ on\ debt\ of\ the\ Solar\ Business$
$D_R = Depreciation\ Rate\ for\ the\ Rental\ Investment$
$D_S = Depreciation\ Rate\ for\ the\ Solar\ Investment$
$PPD_R = Principal\ Pay\ Down\ of\ debt\ of\ the\ Rental\ Business$
$PPD_S = Principal\ Pay\ Down\ of\ debt\ of\ the\ Solar\ Business$
$C_R = Capitalized\ cost\ of\ the\ Rental\ Business$
$C_S = Capitalized\ cost\ of\ the\ Solar\ PV\ System$
$t = tax\ rate$

Assuming equal financing terms and debt-equity percentages for both the rental and solar businesses, and that pre-tax cash flows for each business are sufficient to cover debt service, then the ratios of after-tax debt service to capitalized costs for both businesses will be equal. We can therefore substitute *E*2.1 and *E*2.2 in *E*2 above, cancel the debt service terms, and group remaining terms to obtain:

$$\frac{[(EBITD_R + EBITD_S) \times (1-t) + (D_R \times C_R + D_S \times C_S) \times t]}{C_R + C_S} \geq \frac{[EBITD_R \times (1-t) + (D_R \times C_R) \times t]}{C_R} \qquad (E2.3)$$

$$Let:\ \frac{EBITD_S}{C_S} = p \times \frac{EBITD_R}{C_R}, \qquad 0 < p \leq 1$$

$$Then\ (E2.3)\ will\ hold\ if:\ D_S \geq D_R + (1-p) \times \frac{EBITD_R}{C_R} \times \left[\frac{(1-t)}{t}\right]$$

As an example, suppose the following inputs are given:

$EBITD_R = \$8$
$EBITD_S = \$1.2$
$C_R = \$100$
$C_S = \$20$
$\frac{EBITD_R}{C_R} = 0.08, or\ 8\%$
$\frac{EBITD_S}{C_S} = 0.06, or\ 6\%$
$D_R = 3.64\%\ (straight-line\ method\ over\ 27.5\ years)$
$t = 30\%$

$Then:\ p = 0.75\ and\ D_S \geq 8.3\%$

Thus, in this one-period example, where pre-tax yields on the rental and solar components are, respectively, 8% and 6%, as long as the depreciation allowance for the solar equipment is 8.3% or greater, the after-tax return for the solar-rental business will equal or exceed that of the rental business alone.[6] As a reference, the Modified Accelerated Cost Recovery System (MACRS) depreciation schedule available to solar energy investments is listed below:

Year	Depreciation %
1	20%
2	32%
3	19.2%
4	11.52%
5	11.52%
6	5.76%

Fewer Properties Needed; Easier to Manage

Rental property investors who allocate a portion of their capital to solar energy generation on existing homes will need to source and bid on fewer properties to achieve their targeted returns. This will help mitigate cap rate declines resulting from increasing competitive pricing pressure. For example, assuming an average distressed home price of $100,000, a solar PV system with 4 kilowatts (kW) of capacity installed at a cost of $5000/kW, and a "solar home-to-total home" ratio (SHR) of 0.5, approximately 90% of investment funds would be needed for actual home purchases. The remaining 10% could be invested in solarizing existing properties to achieve ROI targets.[7] Fewer properties under management will also mean a reduction in management expenses and in the effort required to administrate a large portfolio of homes.

Increased Sales Prices

Homes with solar panels have commanded sales premiums relative to properties without PV systems as evidenced in a hedonic home price study conducted in California, the state with the most installed residential systems, using home-sales data from 2000 to mid-2009. The study's results indicated an average sales price premium of $5.5 per installed watt (W) of PV, which corresponded to both the average cost of installing the system and the expected annual electricity cost savings associated with the systems (Hoen, Wiser, Cappers, & Thayer, 2011).[8] For existing homes with PV systems five or more years old, the average was closer to $5/W, or about the

[6] It is also assumed that the pre-tax income of the combined solar-rental business is large enough to absorb the depreciation allowances from the individual operations. Even if the absorption occurs over more than one time period, it is still possible to achieve superior returns for the solar-rental business with stricter parameters.
[7] Prices based on Southern California-area distressed homes at the time of the initial study and an average of solar capacity from several case studies. Competitive pressures are likely to have driven average home prices upward, even as solar costs continue to decline. SHR<1 assumes that not all homes will be candidates for solar.
[8] Assumes $0.20 per kilowatt-hour as the marginal cost of electricity at the time of the study.

average cost of installation today without subsidies. This does not include, of course, the realized electricity savings prior to the home's sale (Hoen, Wiser, Cappers, & Thayer, 2011).[9]

Offset to Vacancy Costs

Solar panels on rental roofs can help offset lost revenues from vacancies by satisfying interim power needs and contributing electricity to the grid. To the extent the PV generation exceeds demand – for base-level lighting, heating, etc. - during a vacancy, the excess would be net-metered to the grid and credited at prices ranging from the wholesale rate to the full retail rate, depending on the state, utility, and billing arrangement. For example, assuming a base-level demand of 100 kilowatt-hours (kWh), equivalent to two 65-watt bulbs running continuously for a month of vacancy, a 3 kW solar PV system's excess generation in the Southern California Edison (SCE) utility region would be credited at approximately $0.13 per kilowatt hour (kWh) to the subsequent month's bill. The dollar value would be approximately $35-$40.[10] For a portfolio of 1,000 homes experiencing an average of one month of vacancy per year, the savings would be meaningful.

Expanded Investor Base

Combining environmental goods, i.e., solar electricity, with home rentals as a business model would expand the investor base for the underlying real estate venture to include socially responsible funds and other environmentally-conscious private/corporate investors. Solarized properties would also create opportunities for additional financing and exit strategies, including solar-rental REITs and solar asset-backed securitizations, which would, in turn, help catalyze broader adoption of solar energy by capital markets participants attracted to the returns offered by such traditional instruments.

Increased Tenant Quality

While tenants would not enjoy economic advantages from the solar PV systems themselves, the presence of the systems could attract more responsible clientele, resulting in lower collections losses and legal costs. In areas of concentrated solar rentals, the quality of the entire community could benefit as a result, translating to increased home values.

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[9] An updated study using more recent results is clearly warranted and would likely reflect the continuing declines in PV system costs, increases in generating efficiency of panels, and electricity rate inflation, among other factors. Interestingly, however, the post-incentive PV costs over the time period of the study remain close to today's net system costs, a result of higher incentives during the study period but lower gross costs today.

[10] This assumes the property owner is the utility account-holder which would facilitate the rollover of credits. SCE customers, like most utility customers in California, are allowed to roll over excess generation for twelve months, at which time they can opt to continue rolling over or to receive compensation at the wholesale rate, which has typically averaged $.03-$.04/kWh.

Economies of Scale

Solarizing many residences in concentrated distressed markets will facilitate the negotiation of price discounts from installers and the streamlining of permitting with local municipalities, thus mitigating two of the significant "balance-of-system" cost components. As a result, the returns modeled in the study may be understated. However, estimates of the magnitudes and impacts of such economies have not been attempted for this study.

Environmental Leverage

Solar panels are an environmentally sound choice for generating electricity and reducing the need to burn fossil fuels. This strategy could accomplish utility-scale investments in residential solar energy via the initiatives of just a handful of large property owners. It would be many times more efficient a method to solarize residential properties that: (a) will eventually revert to individual ownership and (b) otherwise would require thousands of individual owners' willingness and capital. It is estimated that the top institutional distressed home buyers have accumulated 40,000-50,000 distressed properties since 2009 and that they are expected to purchase upwards of 100,000 additional homes over the next two years (Perlberg & Gittelsohn, 2013) (Mlynski, 2013). Given 300,000 U.S. residences with solar panels as of year-end 2012, if half of the expected portfolio of institutional single family rentals was to be solarized, it would result in a 25% increase in the stock of residential solar installations.

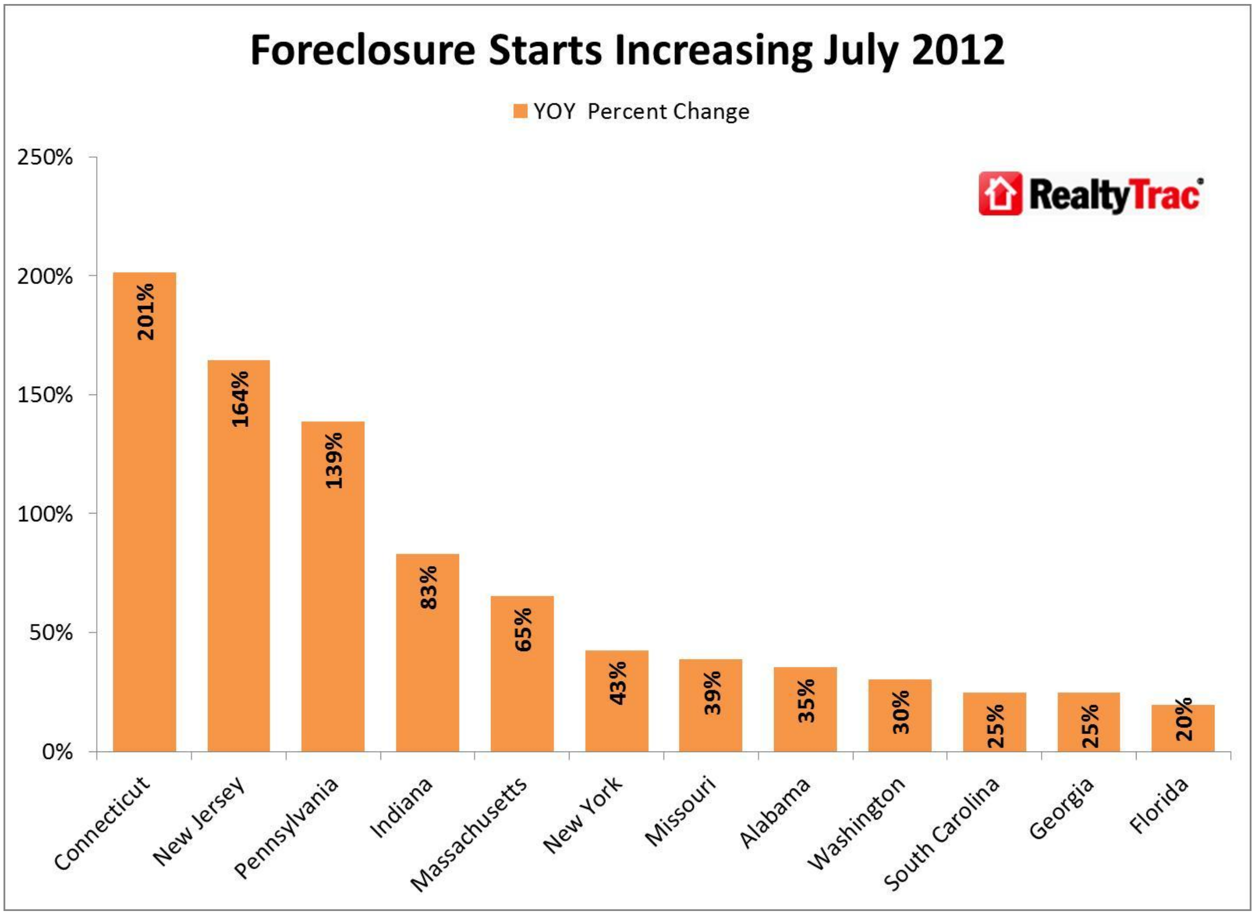
Assessing the Distressed Single Family Home Market

The distressed single family housing market includes the "shadow inventory" of homes that are in the foreclosure pipeline – and may already be part of bank/GSE REO portfolios – or homes whose owners are at least 90 days delinquent on their mortgages. The "shadow inventory" stood at about 3.1 million, or 6% of the 50 million home loans in the U.S. as of Q3 2012. These numbers have improved from the trough of the housing recession over the last few years, when the "shadow inventory" hit 4.5 million homes (Laing, 2012). In addition, close to 11 million residential properties were still "underwater", or in a state of negative equity, with mortgages that are greater than the values of the homes (CoreLogic, 2012).

Foreclosure filings - default notices, scheduled auctions, or completed bank repossessions – were reported on over 1,800,000 U.S. properties in 2012, down 36% from the 2010 peak. Many of the states experiencing the greatest declines, including the "sand" states hardest hit by the recession – California (-25%), Arizona (-33%), and Nevada (-57%) - use a non-judicial foreclosure process that facilitated faster outcomes in the early post-crash period and attracted institutional investors offering all-cash purchases at significant discounts to market. These states remain, however, among the leaders in overall foreclosure rates, with Nevada and Arizona each at 2.7% of housing units in foreclosure (RealtyTrac, 2013 a). As of year-end 2012, California still had seven of the top twenty metropolitan foreclosure rates, including the top four – Stockton (4%), Riverside-San Bernardino-Ontario (3.9%), Modesto (3.8%), and Vallejo-Fairfield (3.7%). Florida boasted eight of the top twenty and was among the judicial foreclosure states seeing the largest increases in metropolitan rates (RealtyTrac, 2013 b). Among states seeing foreclosure rate increases, twenty use a longer, judicial process for resolving foreclosures. One of them, Florida, posted the highest outright rate (3.1%), while a number of Northeast judicial states joined Florida in posting among the highest increases in foreclosure activity, including New Jersey (+55%), Connecticut (+48%), and New York (+31%) (RealtyTrac, 2013 a). New Jersey and other Mid-Atlantic judicial states have backlogs of tens of thousands of foreclosure cases just now wending their way through the courts after being at a standstill since 2010 while the courts investigated major lending banks for due diligence issues in a "robo-signing" scandal (Gittelsohn & Gopal, 2012).

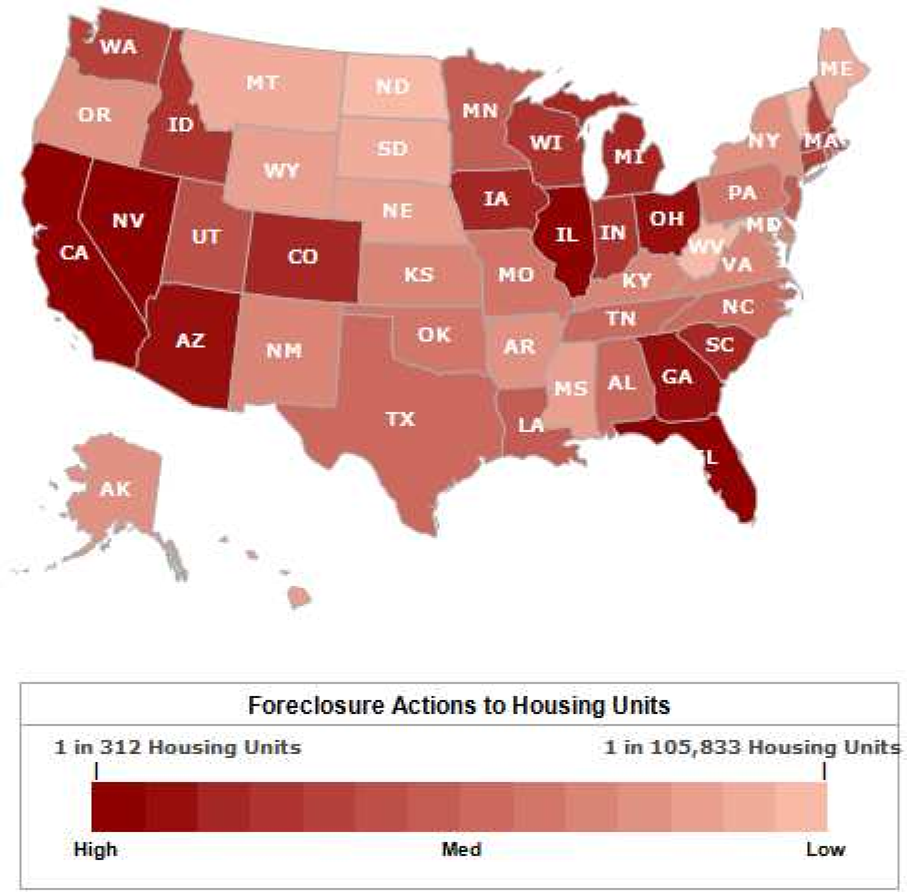
Figure 1 below, from RealtyTrac, indicates the growing foreclosure pipeline in the Northeast, while Figure 2 below is a heat map of existing foreclosure volumes by state.

Figure 1. States with Highest Volume of Foreclosure Starts, July 2012



http://www.realtytrac.com/images/affiliates/Foreclosure_Starts_July_2012_Biggest_State_Increases.jpg

Figure 2. October 2012 Foreclosure Rate Heat Map



http://www.realtytrac.com/trendcenter/trend.html

Examination of the Distressed Single Family Home Rental Business

The aforementioned institutional single family home buyers have acquired upwards of 50,000 distressed homes in the past several years, using all-cash offers at distressed sales auctions and through short sales, at discounts to new construction costs as high as 50% (Grant, 2012). Reported purchase prices have ranged from about $50,000 to $150,000 before upfront renovations of $10,000-$30,000.[11] The homes will be rented for several years and ultimately, as housing prices recover, the intention is to securitize the single family rentals, using a REIT or other asset-backed structure, either as an exit strategy or to finance expansion of the business model (Grant, 2012) (Neumann, 2012). Expected returns are based on the rental income and capital gains at the eventual disposition of the properties. While competitive buying pressures have reduced recent yields by a percent or more below reported cap rates of 7-9% in 2012, these would still surpass the cap rates available to multi-family and apartment REIT investors (Whelan R. , 2012). Combining even modest home price appreciation with the initial purchase discounts and targeted cap rates could easily lead to attractive double digit total returns for these properties over a 5-7 year horizon (Whelan R. , 2012). Rental market economics, in general, are increasingly favorable given that over 3 million families have been transformed from homeowners to renters in the years since the housing crash, the increasing demand for housing from younger entrants, and the tight mortgage lending standards of the nation's banks (Harvard University, 2012) (Cook, 2012).

This scale of single family property investment has not been tried before and faces several unique challenges, the most obvious of which is the logistics of managing many distinct properties dispersed over possibly many cities and states. Economies of scale will be difficult to attain which could incentivize developing or buying captive management companies by the larger operators, as some are reportedly doing (Whelan R. , 2012). Single family homes will also require more maintenance than multi-family dwellings. Leveraging the business model through public debt financing and securitizations will likely be difficult until operating experience is established and the ratings agencies are able to render an opinion. However, one investor has recently secured a large private loan that may pave the way for further lending (Neumann, 2012). On the other hand, the distressed purchase prices provide a margin of safety and potential basis for capital gains. Also, tenant turnover is expected to be lower for homes, leading to reduced turnover losses. One strategy to ensure this is to offer two-year leases (Neumann, 2012).

The regions with the most promise for the institutional single-family rental model are typically those with many concentrated (REO) foreclosures and short sale candidates, conditions that have resulted in significant price discounts to cash buyers, and subsequently, rental capitalization rates ("cap rates") in the high single digits. The typical home has 3 to 4 bedrooms, 1 or 2 baths, and a

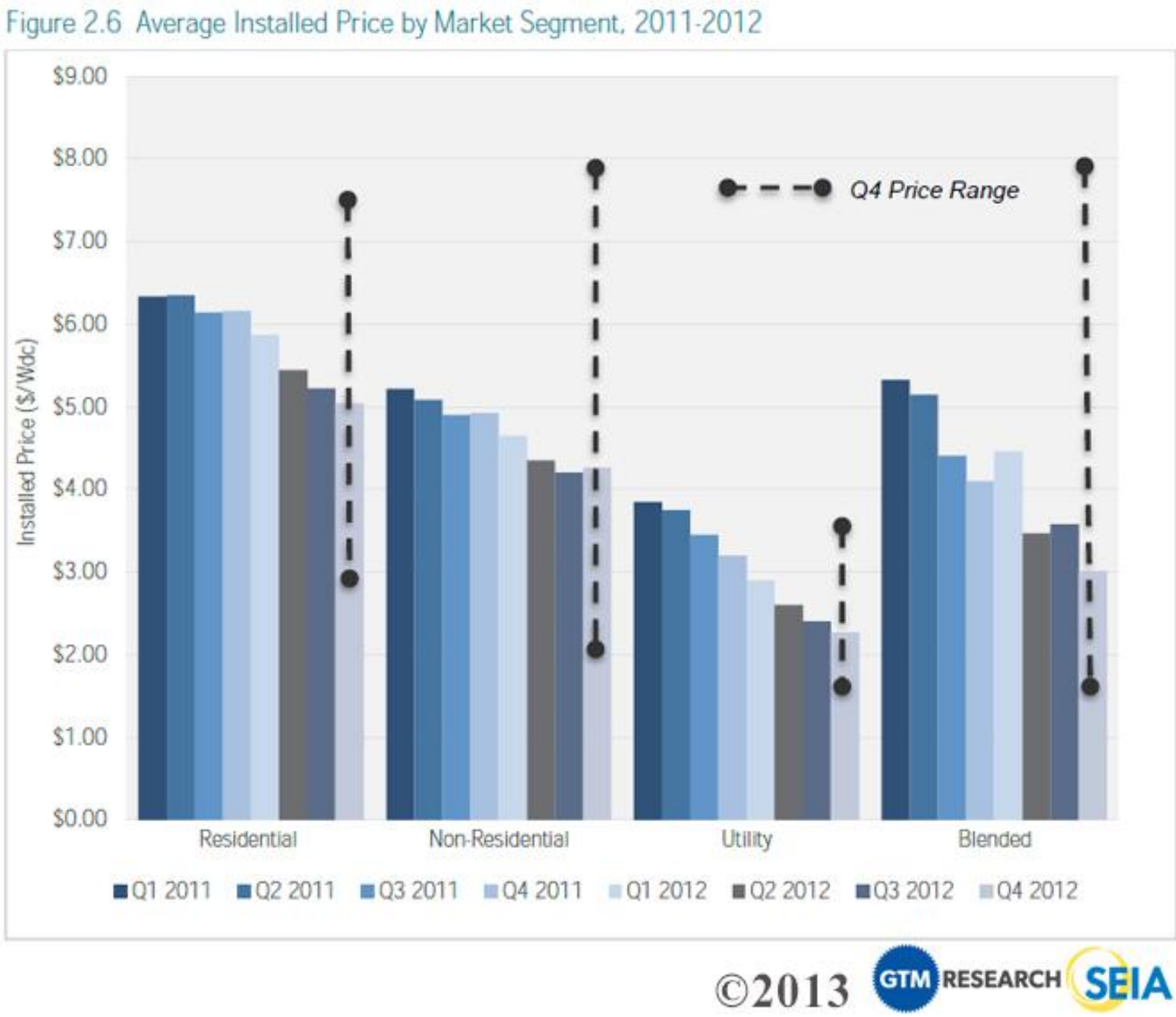
[11] (Grant, 2012) (Yu & Kelly, 2012) (Brzeski J. B., 2012)

garage, and is located within easy commute to a job. Often, the targeted tenant is the very middle-class family that once owned a home in the same neighborhood, but was unable to support the mortgage and yet, still wants to live in a house near their employer and can afford the lower rent payment (Cook, 2012). The Inland Empire metro region east of Los Angeles, the Central Valley, CA, metro areas, Phoenix, AZ, Las Vegas, and Atlanta have been early targets of the institutional “fix-and-rent” or “REO-to-rental” market.

An Overview of the U.S. Solar Power Market in 2012 and the Outlook for 2013-2016

According to the Solar Energy Industries Association (SEIA) and GTM Research, 3.3 gigawatts (GW) of solar photovoltaics (PV) were installed in the U.S. in 2012, a 76% increase from 2011, bringing cumulative U.S. PV capacity to over 7 GW. Utility and commercial installations accounted for 1.8 GW (+134%) and 1 GW (+26%), respectively, of the total. Residential installations numbered 83,000 and accounted for 488 MW, a 62% increase over 2011. There are now approximately 300,000 homes with solar power (SEIA & GTM Research, 2013). This sector has recently been dominated by third-party owners who install (and maintain) home PV systems at little or no upfront cost to the homeowners and then contract with the homeowners to sell them the generated electricity under long-term power purchase agreements (PPAs) or system leases. The national weighted average system price – for all sectors - declined 26.6% year-over-year to $3.01/W (SEIA & GTM Research, 2013). Residential system prices declined by 18.1% year-over-year to $5.04/W, including a 3.5% drop from Q3 to Q4 2012 (SEIA & GTM Research, 2013). Installed costs fell below $4/W in a number of states (SEIA & GTM Research, 2013). A graph from the SEIA and GTM Research year-end 2012 report indicating the range of installed prices by market segment is presented below as Figure 3. Costs vary by state and region based on factors such as local installer rates and permitting costs. As an example, Connecticut’s Residential Solar Investment Program’s latest report indicates an average installed cost of about $5.00/W (Clean Energy Finance and Investment Authority, 2012). Not accounting for the 18% price decline in 2012, a report from the Lawrence Berkeley National Laboratory found 15% of PV systems under 10kW were priced below $5/W in 2011 (Barbose, Darghouth, & Wiser, 2012).

Figure 3. Average Installed Price by Market Segment, 2011 – 2012



As of this writing in October 2012, solar panels for residential installations are selling for approximately $2/W at home improvement centers. Given the total system costs referenced above, the implied "Balance-of-System" (BoS) costs for residential solar comprise just over 60% of the total, a proportion that has been rising over the last few years from 50%+, due to the dramatic decline in module prices relative to gradual changes in BoS costs. These proportions are confirmed by a recent study from Lawrence Berkeley National Laboratory (Wiser & Dong, 2013). BoS refers to all upfront costs of a PV system except the modules: mounting and racking components, inverters, wiring, installation labor, permitting, financing and contractual costs, interconnection, and others (Bony, Doig, Hart, Maurer, & Newman, 2010). A report from the Rocky Mountain Institute outlines strategies for reducing BoS costs by 50% over the next several years for large commercial and utility installations through greater efficiency. Citing a National Renewable Energy Laboratory (NREL) study, Forbes.com suggests that 50% overall cost reductions for residential systems would be possible if the "soft" costs accounting for some 40% – permitting and other paperwork, and interconnection – were streamlined, leading to greater investment and innovation in the industry. Indeed, the U.S. Department of Energy's SunShot Initiative aims to reduce the installed cost of PV by 75%. As part of that project, the Rooftop Solar Challenge is specifically focused on standardizing and streamlining the "soft" costs so as to make solar pricing competitive without subsidies by the end of the decade. The NREL study notes that installer margins for labor and supply-chain markups for materials are each estimated to be 30% for residential PV systems and 20% for commercial installations, vs. 10% for more traditional electrical contracting (Goodrich, James, & Woodhouse, 2012). This leaves ample room for price compression, especially for volume business, as installer experience and competition increases, and as the supply chain becomes more efficient.

GTM Research forecasts a 28% compound annual growth in PV installations for 2013-2016, including 4.3 GW in 2013 (SEIA & GTM Research, 2013). While system prices are expected to continue declining, state-level incentives are also likely to diminish, leaving the federal investment tax credit and, additionally for businesses, accelerated depreciation, as the major initial monetary motivations for PV adoption. These factors will make high insolation, high electricity price states the most attractive candidates for market growth.

An Examination of Federal, State, and Local Incentives, Policies, and Rules Supporting Residential Solar Power

The federal government and a number of states, municipalities, and local utilities have implemented various tax credits, rebate programs, and performance-based incentives to promote residential, commercial, and utility-scale solar power development. The status of all programs is tracked by the Database of State Incentives for Renewables & Efficiency (DSIRE) at www.dsireusa.org. It is important to note that while generous financial incentives have been a major stimulus for solar energy adoption in a number of states over the past half dozen years, they have been declining as original capacity targets are reached and state budgets continue to shrink under economic stress. This study will demonstrate that the combination of declining system costs and high marginal electricity rates in certain utility regions is sufficient to generate attractive returns independent of major incentives.

Federal Investment Tax Credit (ITC)

The biggest stimulus has been the 30% investment tax credit (ITC) offered by the federal government for various renewable energy technologies, including photovoltaics. The credit can be used to offset the income tax liability of the owner/investor. The ITC has helped spur large-scale system development by "tax-equity" investors. At the moment, the ITC is set to expire in December 2016. While the credit can be rolled over to subsequent years if not fully utilized against current year income, it is not clear how remaining portions will be treated beyond 2016. It is important to note for this study, however, that the ITC is not available to rental properties (TIAP, 2011).

Accelerated Depreciation

The government has also allowed accelerated depreciation over five years for PV systems. The 5-year Modified Accelerated Cost Recovery System (MACRS) depreciation can be utilized for PV systems on rental properties (Hagen, 2009). This proves to be an important driver of improved returns for rental properties with solar panels installed. As was illustrated in Example 2 above, MACRS depreciation for solar investments can boost after-tax returns of a solar-rental business by shielding more income in the early years of operation. The 5-year term of the accelerated depreciation should coincide well with the investment horizons of a number of the institutional home buyers.

State, Local, and Utility Tax Incentives and Rebates

State tax incentives include sales tax exemptions on the equipment or total costs of a PV system and property tax exemptions on the additional assessed value of a property with a PV system. Rebates per watt of installed PV are offered by some states, counties, municipalities, and utilities, and are usually taxable at the federal level. Under the California Solar Initiative (CSI), Southern California Edison (SCE) is one of three large investor-owned utilities administering a state Expected Performance-Based Buydown (EPBB) program currently paying a one-time $250/kW for residential systems in its territory (DSIRE, 2012). This is an example of a rebate program with payouts that decline with the achievement of generation milestones.[12] [13] Generally, rebates are limited by an overall budget, and capped by either a maximum system size or maximum credit per installed watt. Often, budgets are shared among applicant sectors including residential, commercial, industrial, non-profit, and other customers. Information on funding prioritization and allocations was not found in such cases.[14]

Performance-Based Incentives (PBIs)

Many states have adopted Renewable Portfolio Standards (RPS), which are regulations that mandate increasing percentages of energy production from a selection of approved renewable technologies. These regulations force utilities/energy suppliers to satisfy the targets by adding renewables to their own generating portfolio and/or by purchasing renewable energy certificates (RECs) evidencing fixed quantities of renewable generation from a marketplace or auction of

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[12] Due to impending quota fulfillment, rebates are close to stepping down to lower levels for certain California utilities, e.g. SCE (CSI, 2013). These lower levels are assumed for the analysis.

[13] Funding for California programs is scheduled to end in 2016-2017.

[14] For example, the Massachusetts' rebate program, though a minor incentive compared to its SREC program, is currently funded at $1.5MM, implying 750 homes at 5kW each, but includes commercial projects, which tend to be significantly larger than residential systems and could easily absorb most of the budget. (See the table 2 - 5 footnotes for details for other markets.)

sellers. RPS schedules are typically fixed for ten or more years into the future so as to provide clarity to renewable project developers/investors. The prices of RECs vary depending on several factors dominated by the supply/demand characteristics at any given moment.

A number of states have created "solar carve outs", or solar RPS, specifically for solar electricity in order to overcome its higher initial cost among competing clean energy sources. Energy suppliers can satisfy their solar RPS through direct generation, the purchase of solar renewable energy certificates (SRECs), or by paying a penalty - the Solar Alternative Compliance Payment (SACP) - for each kWh of solar energy they fall short. SRECs, representing the generation of 1,000 kWh, or 1 megawatt (MW) of solar energy, are sold in public marketplaces and, typically by small generators such as residential homeowners, through monthly/annual auctions. Homeowners with solar PV systems are awarded an SREC for each MW of electricity their systems produce. Depending on the state, SRECs can be purchased from sellers outside the state but within the same electric transmission grid serving a regional group of states. (See www.pjm.com and www.pjm-eis.com.) Solar RPS schedules also specify the current and future SACP levels to be paid for non-compliance. SACPs are typically set high enough to incentivize solar energy investment and decline over time in anticipation of the achievement of the increasing RPS goals. Data on SACPs can be found at SRECTrade.com (SRECTrade, 2013).

In New Jersey, SRECs traded from $225 - $390 during 2012, although for Q1 2013 they have averaged $202 (DSIRE, 2012) (NJCEP, 2013). Recent prices for traded SRECs in Massachusetts have been in the low $200's (Anich, 2013). Both of these markets are currently in a state of oversupply as a result of generation in excess of RPS requirements borne of a combination of falling system costs, increasing RPS, and high SACP levels, all conspiring to offer investors attractive returns. In New Jersey, it may take several years and recently-enacted increases in the solar RPS to restore balance. Massachusetts' program is designed to adjust targets annually based on market conditions and therefore, should be quicker at restoring a balance (DOER, 2013). Massachusetts, like New Jersey, has a market for openly trading SRECs and an auction mechanism whereby sellers can submit their SRECs and receive a clearing price if the SRECs are sold. In Massachusetts, unlike New Jersey, there is a guaranteed floor, currently set at $285, for SRECs that are actually sold at the annual auction (DOER, 2013). Unsold SRECs are re-issued to the seller with a three-year trading life (SRECTrade, 2013 b) (DOER, 2013).

SRECs are the primary PBIs available for renewable energy generation by residential, commercial, and industrial systems. In several states, e.g., Texas, utilities offer an alternative PBI, feed-in tariff (FIT) plans, instead of SRECs. Under a FIT, all customer solar generation is credited by a given utility at a fixed price per kilowatt hour (kWh) for a specified number of years.

Net Metering

Net metering is a policy offered in 43 states as of October 2012 that allows excess electricity generated by a solar installation to be directed back into the grid and credited to the customer-generator. Residential PV systems generate the most power during peak sunlight hours in the afternoon when household power requirements are typically lower. Under net metering, any generated but unused electricity would be directed through the home's bi-directional meter and out into the grid to satisfy other customers' demand. The homeowner would literally experience a reversal in the metered usage of electricity. Their bill would depend on the particular state's or utility's policy for crediting the excess energy. Several states - California, Arizona, and Nevada, for example - mandate that excess generation be credited at full retail rates in the subsequent billing cycle, while in others, credits are at the "avoided cost" or wholesale rate, which can be as low as \$.03-\$.04/kWh. Policies also vary when it comes to the treatment of net excess generation (NEG) at the end of a full year. Some states, such as Nevada, allow indefinite rollovers of credits at the full retail rate, while others force a settlement at wholesale rates and then reset the account to zero (DSIRE, 2012).

Power Purchase Agreements (PPAs) and Solar Leases

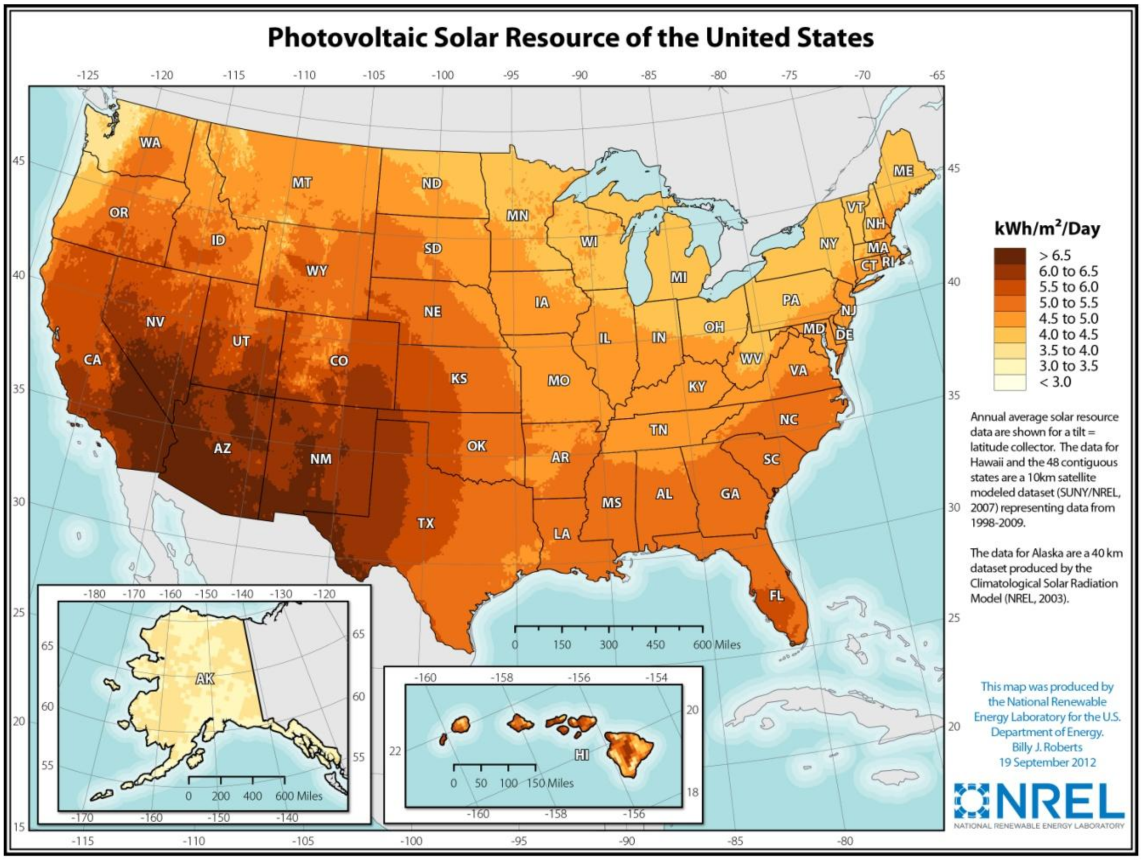
Finally, one of the major catalysts of large-scale commercial, and recently, residential, installations of solar PV systems, in conjunction with RPS regulations, has been the adoption of third-party solar power purchasing agreement (PPA) policies at the state level. Currently, some 22 states, Washington, D.C., and Puerto Rico have instituted third-party PPA rules (DSIRE, 2012). In the context of solar energy, these policies allow third party companies to own PV systems installed on a host property and to charge the host either for the generation from those systems under PPAs, or for the use of the systems under long-term leases. The third parties install the systems at little to no upfront cost to the host, and contract – typically, for 20 years - at rates that guarantee a savings in electricity costs for the host, with possibly, some built-in rate escalation over time as grid prices rise. The rights to any SRECs, ITCs, or other incentives owing to the renewable energy asset remain with the third party owners. These financing arrangements have addressed the chief impediment to wider adoption of solar energy, i.e., the significant upfront costs. The costs of the system are usually borne by outside investors financing the third parties with "tax equity" in return for a share in the cash flow stream and ownership of the federal (and state) investment tax credits and accelerated depreciation that they use to offset their tax liabilities (Himmelman, 2012). Such "tax-equity" financing was a major impetus to industry growth in the U.S. prior to the financial crisis beginning in 2007. However, many of the investors were financial institutions that saw their profits, and tax bills, disappear during the crisis and thus, lost their major incentive for financing further projects. Given the recent return to profitability by major banks and newfound interest by other corporations, including Google, the tax equity market is witnessing renewed growth (Sharif, Grace, & Di Capua, 2011).

The Intersection of Distressed Single Family Rentals and Residential Solar Power

The economics of a solar-rental business model will be most favorable under several concurrent conditions: (1) A regional concentration of distressed real estate; (2) moderate to high levels of insolation; (3) supportive state and local policies and incentives for solar energy; and (4) high marginal electricity rates. As mentioned above, financial incentives, while always helpful, have diminished in importance as system costs have declined dramatically in the past several years, especially in regions with high electricity rates.

Among the states and specifically, metropolitan areas, with the highest past and/or present foreclosure rates that have attracted billions of dollars of “fix-and-rent” institutional investors, are those with the greatest solar irradiance levels in the country. These include the Central Valley and Inland Empire regions of California; Las Vegas, Nevada; Phoenix, Arizona, and others where daily solar irradiance averages approximately 5.5 – 6.5 kilowatt-hours/meter^2 (kWh/m^2/day), making them particularly well-suited for solar electricity development (NREL, 2012). Figure 4 below is a map of solar insolation across the U.S. Of the group, California presents the best economics because its electricity rates are among the highest in the nation, averaging about $0.15/kWh in 2011, and much higher on a marginal basis in some utility regions (EIA, 2011).

Figure 4. Solar Insolation (kWh/m^2/day) across the U.S.



http://www.nrel.gov/gis/images/eere_pv/national_photovoltaic_2012-01.jpg

New Jersey, New York, Connecticut, and other Mid-Atlantic/New England states have some of the highest electricity costs in the nation, moderate solar insolation, and progressive renewable energy policies that include generous upfront rebates or performance-based Solar Renewable Energy Credits (SRECs). The combination of high-cost power and the incentive programs run by these states makes them well-suited for a solar-rental operation. Supply of distressed properties has been slowed in these states by delays in their judicial, or court-administered, foreclosure systems. One of the big differences between this region and the high insolation markets of the southwest is that the Northeast states tend to be judicial with respect to the foreclosure process. This means that each foreclosure is subject to a long court-administered procedure that can last nine months or more before being finalized. The implication is for a more gradual supply of foreclosed properties and possibly, less distressed pricing than in the southwest. On the other hand, a recently settled lawsuit accusing major lending banks of unlawful foreclosure processing will unleash a pent up docket of cases in these and other states. New Jersey alone had 60,000 foreclosures begun in 2008 and still awaiting resolution as of late

2012 (Gittelsohn & Gopal, 2012). New Jersey and New York have the second and third highest foreclosure inventories as a percentage of all mortgaged homes, at 7.2% and 5.0%, respectively (CoreLogic, 2013). Many of these homes will hit the market over the next few years, coinciding with further reductions in solar PV system costs, auguring well for the solar home rental business model.

Indeed, several markets that do not offer a compelling solar rental proposition today could do so as either PV system costs decline further over the next one to two years or targeted net rental yields continue to decline as property prices rise, or some combination of both. If, as industry participants expect, non-leveraged yields on residential rentals fall from current levels of approximately 7% to the 5.5% levels of apartment rentals, then a number of additional markets are likely to become economically attractive for the solar-rental paradigm (Yu & Kelly, 2012).

Key Business Elements of a Solar-Home Rental Operation

PV System Installation and Maintenance

For the analysis, it was assumed that roof repairs/replacements are performed as part of initial capitalized renovations at the time homes are purchased for rental portfolios. Thus, no additional renovation expense is foreseen in anticipation of the solar panels. Also, solar panels will help preserve the sections of roofs they sit on.

The major steps in the development of a residential PV system include site assessment, reviews, permitting, installation, inspections, and utility interconnection. A California study found median development times of approximately three months and various initiatives are underway to dramatically reduce the timeframe (and costs) (Wiser & Dong, 2013). For these reasons, the best strategy, from both a pricing and implementation perspective, will be to engage a small number of installers who have worked extensively with local municipalities. It might also be advantageous to work directly with a manufacturer of panels that has established expertise on the installation side of the business.

Very little maintenance is required for solar PV systems once installed. An occasional cleaning with water is usually enough to maintain peak operating conditions. Periodic rainfall is reportedly effective as a cleaner. Replacing the inverter is the biggest post-installation expense. Both of these have been accounted for in the case studies below. (See Appendix 2.)

Personnel Requirements

Most of the administration of the solar PV system is in the initial contracting and permitting, applying for upfront incentives, developing a billing system (see below), and preparing the legal documents. One-time legal fees would be incurred to draw up PPAs, or their variants, in each jurisdiction, that would become part of the rental agreements. Ongoing management involves monthly accounting for the solar generation, which ought to be done via online access to accountholder information; billing; arranging the occasional maintenance of the panels; and, in states with SREC programs, the periodic registering and selling of these credits as they reach trade-worthy quantities. (See the discussion under the Examination of Incentives and Policies above and Appendix 2 for further details on SRECs). Existing personnel from the rental operation might be trained to assume most of the duties of the solar operation. Personnel handling the billing function would manage the process of registering and selling the SRECs. The analysis assumes that one extra head count per 1,000 homes in a given geographic region should suffice as overall manager/supervisor of solar operations. Costs for the manager and the maintenance are included in the case studies and detailed in Appendix 2.[15]

Billing the Tenant for Solar Electricity

Billing the tenant for the solar electricity consumption will depend on state, local and/or utility rules regarding landlord-tenant utility account ownership, rules regarding solar rebates and other incentives, and policies concerning investor-owned utilities (IOUs) and the structuring of third-party PPAs with tenants. Third-party electricity sellers face challenges in some jurisdictions where they may be deemed monopoly utilities or competitive suppliers, either of which could be subject to regulation. A number of states have addressed IOUs, usually in some accommodative way, to promote renewable energy investment (Kollins, Speer, & Cory, 2010).[16]

Several potential billing arrangements seem plausible with either the tenant or the landlord as the utility account-holder:

1. Tenant is the Utility Account-Holder

(a) The landlord would charge the tenant each month for the value of the solar production at the retail rate.

(b) The landlord charges an additional rent to account for the expected solar generation value. In this case, an end-of-year credit/debit "true-up" would be carried out.

2. Landlord is the Utility Account-Holder

(a) The landlord would charge the tenant each month for the value of the solar production at the going retail rate plus the charges billed to the landlord by the utility.

[15] Note that the costs for managing the solar operation do not account for the savings to be achieved from having to manage fewer properties overall. (See the discussion under the Synergies section above.)

[16] The arrangement to be used by the property owner to sell solar power to the tenant is, essentially, a PPA. While the DSIRE website indicates third-party solar PPAs being authorized in all states included in the study, local exceptions may exist, and PPAs in the context of a landlord-tenant relationship are not discussed. These legal issues were beyond the scope of this study and require further investigation.

(b) The landlord charges an additional rent to account for the expected total value of electricity – grid and solar – to be used by the tenant plus fixed charges by the utility. In this case, an end-of-year credit/debit "true-up" would be carried out.

Example for Monthly Billing. Suppose the billing cycle is two days long and on day one the tenant uses 10kWh of grid-supplied power while on day two they use 10kWh of panel generated power, and the production meter[17] indicates 10kWh of overall production. The utility bill would show a usage charge for only 10kWh. For arrangement 1(a), the tenant is charged by the landlord for 10kWh. For 2(a), the tenant is charged for 20kWh since the landlord is billed by the utility for 10kWh and will also bill for the solar generation. If, for a given month, the PV system produces more power than is consumed by the tenant, a net credit would appear on the utility bill. For either arrangement 1 or 2, the landlord would bill for the amount shown on the production meter less the credit, equivalent to the tenant's solar usage.[18]

Under arrangement 1(b) or 2(b), the landlord would need to use prior year usage data for either the existing tenant or past tenant(s) to assess the likely usage pattern so as to price the expected solar production according to the current rate structure, including tiers. 1(b) and 2(b) may avoid separate "solar billing" each month and thus, result in a more efficient process. However, usage would still have to be tracked so as to reconcile any end-of-year imbalance.

In all cases: (i) the solar billing should account for any avoided costs in higher rate tiers that would have been incurred by the tenant in the absence of the PV system; and (ii) additional security deposits would be required of the tenant in proportion to the type of solar billing arrangement, i.e., greater deposits when the landlord is the account-holder and lesser deposits when the tenant holds the account and the landlord will only bill for solar generation.

As discussed above, the personnel handling overall billing for the rental operation should be able to administer the solar billing, with oversight from the solar operation manager.

An Economic Model of a Solar-Home Rental Operation

In order to analyze the investment implications of a business that would combine home rentals with the sale of solar-generated electricity to the tenants, a comprehensive financial model was developed in Excel and applied to twelve markets for a ten-year investment horizon. With respect to the rental operation, the model incorporates the economics of buying distressed properties, renovating them, renting them, and selling them at the horizon date. Operating expenses, debt, depreciation, depreciation recapture at sale, accelerated loss carryovers at sale,

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[17] The production meter can separately measure how much generation came from the solar panels each month.
[18] It is not expected that the size of the systems installed would lead to overall net generation in excess of grid demand for a given month or an entire year.

and all federal-level taxation are accounted for. Rental rates and expenses are subjected to annual escalation. Appendix 1 provides explanations of the assumptions and values used for the major operating variables in modeling the rental business. With respect to the solar PV system, the model incorporates the economics of installation, the value of expected system generation, maintenance, and the projected value at sale of the property. Electricity rates, and therefore, system output values, are subjected to annual increases. All substantive state, local, and or utility incentives, including rebates, tax exemptions, and SRECs, are accounted for. Debt, accelerated depreciation, state sales taxes on the equipment and/or labor, and federal-level taxation of revenues are also incorporated. Appendix 2 details the major variables, approaches, and values used to model the solar operation. The model calculates the economic returns for each component operation – rental and solar – and for the combined solar-rental operation, the latter reflecting the tax synergies offered by the solar investment. Following is a discussion of the model's results for thirteen case studies from twelve markets. In one of the markets – Riverside, CA – two very distinct utility rate structures suggested different strategies for sizing a PV system – in one case to satisfy a majority of the home's electricity needs; in the other, to target the highest-cost portion of electricity use under a tiered pricing scheme. A generalized algorithm is developed to determine the optimal sizing of a PV system to capture only those marginal rate tiers sufficiently greater than the levelized cost of the system to produce attractive returns.

Discussion of the Results from Twelve Geographic Markets

The economics of combining solar electricity sales with single family home rentals were evaluated for the following markets: (1) Phoenix, Arizona, (2) Riverside, California for two different utilities, (3) Connecticut – various counties, (4) Atlanta, Georgia, (5) Indianapolis, Indiana, (6) Maryland – various counties, (7) Massachusetts – various counties, (8) Las Vegas, Nevada, (9) New Jersey – various counties, (10) Nassau County, New York, (11) Charlotte, North Carolina, and (12) Nashville, Tennessee. All these markets have experienced or are expected to experience high rates of home foreclosures. The Southwest markets – Phoenix, Riverside, and Las Vegas – have some of the highest foreclosure intensities in the country. (See Figure 2 above.) They also enjoy among the highest levels of solar insolation. (Figure 4 above.) The Northeast markets – Connecticut, Maryland, Massachusetts, New Jersey, and New York – receive moderate insolation, have large backlogs of judicial foreclosures, and generally, have strong incentive programs for solar energy. For each market, the model was used to analyze the economics of the rental operation, the solar electricity sales operation, and the combination of the two, over a ten year horizon. 50% debt financing at a 5% borrowing rate was assumed. (See Appendix 1.) Average capitalization rates, pre-tax cash flow IRRs, and after-tax cash flow IRRs were calculated. The after-tax IRRs were calculated under two scenarios: (i) tax losses, as a result of, for example, depreciation allowances, were carried forward and used in subsequent years and (ii) all current-year tax losses were assumed to be utilized by the investor to offset other tax liabilities.

Table 1 below lists the common assumptions regarding operating costs, solar installation costs, escalators, taxes, and other variables that were discussed in the above sections for each operation. All case studies but three assumed an installed capacity of 5kW DC of solar panels. The Las Vegas, NV and Riverside, CA – Riverside Public Utilities cases used 6 kW DC of panels, while the Riverside, CA – Southern California Edison case study used 2.5 kW DC of solar panels. The former was driven by high incentive rebates. The latter was a function of optimal system size to capture the best economics with high marginal-cost electricity, as will be explained below. Tables 2 - 5 below contain the data specific to each of the case studies. The tables are divided into two parts: a) Inputs: Property Costs & Rents; PV System Costs & Revenues; Electricity Data & Solar Incentives and b) Results: Cash Flow Returns for the Rental, Solar, and Solar-Rental Operations, respectively. For ease of reference, the marginal electricity rates, SREC prices, upfront rebates, and pre-tax revenues from the solar electricity sales were reproduced in part b. of each table. Highlighted figures in part b. represent "competitive" outcomes where after-tax cash flow returns from the solar-rental business generally matched or exceeded those from the rental operation alone. In particular, Table 5 presents the model's results for two utility scenarios in the same city/county of California: Riverside. One of those, for Riverside Public Utilities (RPU), is repeated here from Table 2 for comparison's sake. Several themes are evident in the results.

After-tax returns from the modeled solar-rental businesses appeared to be competitive, i.e., within 0.10% of, or greater than the rental-only benchmarks, in five of the thirteen case studies. These are highlighted in parts b. of Tables 2, 3, and 5. The competitive markets are generally characterized by high electricity rates, moderate to high solar insolation, and attractive upfront or performance-based incentives. For example, Riverside, California, with two competitive results, has among the highest marginal electricity rates in the U.S. - approximately \$0.16/kWh for RPU and up to \$0.36/kWh for SCE (Table 7) – and, for RPU customers, among the highest upfront rebates of \$2,000/installed kW[19]. Combined with the high insolation of this region, these attributes led to after-tax returns of 7.76% and 7.60% for RPU and SCE, respectively, compared to 7.61% for the rental operation alone (Table 2b.) In the Northeast, the three markets with competitive results – Massachusetts, New Jersey, and New York – have among the highest electricity rates and either SREC programs or generous rebates. Note that New Jersey's combined solar-rental result was only eight basis points below its rental-only figure, and thus, was included among the highlighted markets. In point of fact, if New Jersey's SREC prices were to average only 63% of the Solar Alternative Compliance Payment (SACP) levels, instead of the assumed 50%, its after-tax solar-rental returns would match the rental yields. (See the Examination on Incentives and Policies above and the SRECs section in Appendix 2 for

[19] Program set to reopen July 2013 (City of Riverside, CA, 2012). Last year's budget was \$2MM, equating to 200 homes at 5kW/home. A prior-year application backlog is pending and will absorb an unknown portion of the new budget. (See the discussion on rebates under the Examination of Incentives and Policies above and in Appendix 2.)

background on the SACP.) Massachusetts, with $0.15/kWh electric rates, relatively high SREC prices ($220), and a modest rebate program ($400/kW), produced combined results that were 0.19% above rental returns alone. The eight remaining markets generally have either low electricity rates, meager incentives, or a combination of both.

Table 6 below shows the results of a two-parameter sensitivity analysis of after-tax IRRs. For each market, current and 20%-discounted prices (from the mean) were used for the solar panel system, and current and 25%-discounted values were modeled for the incentives, both upfront and performance-based. Results are compared to rental-only returns. The 20%-discounted solar price ($4.00) is still well above the lower end (~$3.00) of currently reported market prices (Figure 3) and is reasonable to expect over the next year or so given existing trends and the presumed economies of scale available to a large volume operation that were discussed under Solar-Rental Synergies above. The 25% incentive discount reflects continuing trends among state/local/utility programs due to budget constraints and planned phasing out of incentives as targeted installed capacities are reached. The decreasing incentives also anticipate lower system prices over time. At a 20% lower PV system price, the Riverside, CA – RPU solar-rental yield has a 0.43% advantage over rental-only returns; Massachusetts' advantage rises to 0.36%; New Jersey's slight solar-rental yield disadvantage becomes a 0.16% advantage; and Maryland's and Nevada's solar-rental returns reach levels competitive with the rental-only values. Four of five currently "competitive" markets continue to fare well even with 25% incentive losses and no price change. (Here, once again, New Jersey would remain competitive with a modest increase in SREC prices.) Finally, in what is perhaps the most likely future scenario, i.e., falling prices and incentives, all the competitive markets remain so, including Nevada and Maryland.[20]

It is important to note that New Jersey and Massachusetts are two SREC markets in a current state of oversupply. While New Jersey has legislated increased RPS targets over the next several years that should help to restore balance, and Massachusetts' program adjusts each year in response to market conditions, this will mean some continuing period of depressed SREC prices. The model's assumptions are consistent with current prices. Therefore, if prices even partially recover in coming years, actual returns would be higher than portrayed. (See the discussion under the Examination of Incentives and Policies above and the notes on SRECs in Appendix 2.)

Optimal Sizing of a PV System in the Presence of High Marginal Electricity Rates

The Riverside, California – SCE case study above provides an opportunity to develop a scheme for optimizing the size of a PV system so as to satisfy only that portion of a household's electric demand that would otherwise "spill" into the highest-cost tiers of the utility's rate structure.

[20] These results do not even account for a number of the economic synergies of a combined operation discussed above, including a reduction in the number of homes to be purchased and managed when a portion of assets under management is being used to install PV systems.

Specifically, the targeted capacity should generate a return equal to or above the homeowner's/investor's hurdle rate, accounting for taxes and financing. An SCE residential rate schedule (Schedule D), filed on 12/31/2012 and reproduced in Table 7 below, indicates electricity rates as high as \$0.36/kWh for usage above 1440 kWh/month and 945 kWh/month during summer and winter seasons, respectively. A typical electricity demand profile for a Riverside home with approximately a \$100/month electricity bill is depicted in Table 8. By inspection, this home would incur Tier 3 summer rates and Tier 4 winter rates for portions of its annual energy demand. The long-term levelized cost of a solar PV system (LCOE) for Riverside - SCE was calculated to be approximately \$0.145/kWh using the solar operating assumptions for expenses, incentives, financing, etc. in Table 1 and Appendix 2. At this rate, the IRR is 0%. However, for the solar-rental operation, the hurdle rate is 7.61% after-tax, equivalent to the rental-only return (Table 5b.). This target was achieved[21] by modeling the output of a 2.5 kW system, which would be valued at an average of \$0.21/kWh in terms of the avoided grid electricity it produced for the sample home. Note that this system size is only about half that of the other case studies, whose utility rate structures were not as highly differentiated as SCE's, or as highly priced. Thus, the SCE example shows that, in the absence of generous incentives, solar electricity can still be a very attractive proposition when high marginal rates prevail in the utility's cost structure.[22]

A Model for Optimizing the Size of a PV System

When electric utility rate schedules are tiered based on a customer's cumulative monthly demand and the higher-tier rates are significantly above the levelized cost of the solar power, the optimal strategy would target just enough solar generation to offset demand that would otherwise "spill" into those more expensive tiers. The calculation of the desired system size can be expressed via an optimization model that seeks to maximize the savings in electricity costs per unit of solar capacity. Below is a general specification of the model:

$$Max\ \frac{Savings}{nkW\ PV}$$

$$S.T.\ Savings > FC + O\&M + DS$$

$where$:

[21] Actual results differed from the rental-only yield by < 1 bp.

[22] Note that Riverside, CA is just one city of hundreds in SCE's utility region and it was chosen for the case study in order to compare results under two different utility rate structures and incentive schemes: those of SCE and RPU. Also, solar insolation is, of course, the same for the two cases. In reality, several million customers across hundreds of cities in SCE's territory could possibly benefit from avoiding SCE's higher rate tiers through solar electricity generation. The pricing structure is the same for all customers. What differs, based on a customer's location, is just the baseline electricity allowance each month that determines the (kWh) thresholds for moving from tier to tier.

$$
\begin{aligned}
nkW\ PV &= n\ kilowatts\ of\ direct\ current\ (DC) of\ photovoltaic\ panels, \\
n &= 1, 1 + x, \dots m, x = arbitrary\ increment, e.g., 0.5 \\
m &= maxkW = \#\ kW | Savings(m - x) \geq Savings(m) \\
FC &= pro - rated\ fixed\ costs/home\ \ (mostly\ personnel) \\
O\&M &= operating\ \&\ maintenance\ costs\ (yearly\ cleaning; replace\ inverter\ (10\ yrs)) \\
DS &= Debt\ service\ (Principal + Interest) \\
Savings &= average\ electric\ bill\ without\ solar - average\ electric\ bill\ with\ n\ kW\ solar \\
&= \overline{EB} - \overline{EBnS} \\
\overline{EB} &= \sum_{i=1}^{12} \sum_{j=1}^{k} \overline{D_{ij}} \times r_{ij},\ \ i = month,\ j = tier, k = \#\ tiers\ in\ rate\ schedule \\
\overline{D_{ij}} &= avg\ demand\ (kWh) for\ tier\ j\ in\ month\ i, \\
r_{ij} &= rate\ for\ tier\ j\ in\ month\ i \\
\overline{EBnS} &= \sum_{i=1}^{12} \sum_{j=1}^{k} \overline{NDnS_{ij}} \times r_{ij} \\
\overline{NDnS_{ij}} &= avg\ net\ demand\ (kWh)\ for\ tier\ j\ in\ month\ i\ with\ nkW\ PV \\
&= Max \left\{ \overline{D_{ij}} - Max \left[(\overline{GnS_i} - \sum_{y=j+1}^{k} \overline{D_{iy}}), 0 \right], 0 \right\} \\
\overline{GnS_i} &= avg\ total\ generation\ (kWh) in\ month\ i\ from\ nkW\ PV
\end{aligned}
$$

The objective function is solved for all reasonable values of n. A simplifying assumption of this model is that the installed cost of solar per watt will be constant regardless of the size of the residential system. In practice, per-watt installation charges might vary based on economies of scale and volume discounting. The above specification is designed to be solved for the optimal unlevered savings yield. It could easily be modified to constrain for debt service and/or a specific dollar savings amount. In either variation, a number of iterations might be required to find the optimal system size.

Figure 5 is a graph of outcomes from applying the optimization model on varying levels of solar capacity (n) for the Riverside – SCE home above. One can think of the graph as an “efficiency curve” for a PV system designed to offset a portion of the sample home’s demand. The curve depicts the pre-tax, unlevered return on investment vs. system size for the first-year. This is a reasonable proxy for overall efficiency in the absence of knowledge of future rate levels. Fixed and variable operating costs have been incorporated. The steep initial rise in efficiency reflects dramatic improvements in average costs as the fixed costs are spread over more solar capacity. The curve peaks where the average return for increasing the system size begins to decline due to marginal savings that are now derived from lower-cost rate tiers. Note that the graph seems to indicate a peak somewhat lower than the 2.5 kW in the case study. For the case study, the system size was maximized jointly for total dollar savings in electricity costs and after-tax return.

Conclusion

The economic recession that began in 2006-2007 plunged millions of single-family homeowners into delinquency or default on their mortgages, erased an average of 35% and up to 62% of home values in major markets, and set the stage for a new institutional investment class: single family home rentals. At last count, a dozen or more large established real estate managers and bespoke private equity funds have purchased upwards of 50,000 or more distressed properties at fire-sale prices in the hardest-hit states and regions, renovated them, and rented them, generating unlevered yields of 7%-9% initially, and somewhat less as competition has heated up. Their strategy is an unprecedented attempt to manage large multi-state portfolios of homes as rentals and sell them into recovering housing markets several years hence. Concurrently, prices for residential solar energy systems have been on a steep decline, such that, in a number of regions with moderate to high solar insolation and pro-solar state and local policies, the pre-tax ROIs of a home solar PV system and the after-tax yield on a combined solar-rental operation are comparable to the respective returns from home rentals alone. Among the hardest-hit real estate markets was the Southwestern U.S., and specifically, regions of California where both the sun's intensity and electricity rates are higher than virtually anywhere else in the country, and where solar energy policies have made the state the national leader in solar. A number of Northeastern states with attractive solar incentive programs and high-priced electricity are only now beginning to see a large backlog of home foreclosures reach the market and potentially represent additional markets for solar-home rental investments.

The foregoing analysis encompassed three objectives. The first was to establish a framework for a solar-home rental business model, in which rental incomes are enhanced via the sale of rooftop-generated solar electricity to the tenants of single-family properties. The development of that framework entailed a review of the market conditions and investor activity in the distressed residential real estate sector; an examination of the current economics for residential solar energy, including the various state and local incentives and policies to promote its use; and the synergies that would be realized from a solar-rental business. The second objective was to address several of the major operational elements of a joint solar-rental business, including the installation and maintenance of the solar PV system; the management of the solar operation; and the process for billing the tenants for the solar-generated electricity. The final goal was to model the economics of the individual solar and rental operations, and the combined enterprise, in a number of markets, in order to identify those where the solar-rental strategy would produce attractive returns relative to the rental-only approach. Mathematical models were provided under the discussion of synergies to illustrate both a case where solar returns were competitive with rental yields on a pre-tax basis and the general scenario under which the returns would still be competitive when measured in an after-tax context. An algorithm was also developed for the optimal sizing of a PV system when the objective is to capture the savings from displacing only those tiers of grid-supplied electricity priced sufficiently above the levelized cost of the solar energy to achieve a targeted return on investment.

In several current markets, solar-home rentals promise a number of economic synergies in addition to the obvious environmental benefits that would accrue from the installation of solar energy systems on a large number of homes: (1) After-tax operating yields of the joint business will be enhanced by the accelerated depreciation treatment of the PV systems; (2) Fewer properties would need to be purchased since a percentage of assets under management (AUM) would be invested in the PV systems to generate the same or better ROIs. Fewer homes would be easier to manage, an important consideration given the complexity of a large portfolio of single residences sometimes spread over several states; (3) Solarized homes have been shown to command higher resale prices commensurate with the expected value of future electricity generation; (4) Utility credits for electricity sent to the grid can help offset economic losses from vacancies; (5) Rental properties with solar energy systems would expand the investor base to include socially responsible funds and environmentally conscious private investors. They would also create opportunities for additional financing and exit strategies, including solar-rental REITs and solar asset-backed securitizations; (6) The presence of the systems could attract more responsible clientele, resulting in lower collections losses and legal costs, better communities, and higher sales prices; and (7) Property managers should be able to negotiate volume discounts in the cost of PV systems for large portfolios of homes that would further enhance the ROI of the business.

Most of the effort in managing residential solar energy systems entails the initial development of the PV system - site assessment, reviews, permitting, installation, inspections, and utility interconnection. One-time legal expenses would be incurred for developing PPA agreements between landlord and tenant. Capital expenses for repairing/replacing roofs ought to be part of initial renovations independent of plans for adding solar panels. Subsequent to installation, the systems need minimal maintenance other than an occasional washing. Monthly accounting for solar output and billing for the electricity comprise the major ongoing tasks. Existing billing personnel should be trained to record system production from online account information and process the billing of tenants for the power. It seems feasible for either the tenant or the landlord to be the utility accountholder. In the former case, the landlord would charge only for the solar power while in the latter, the tenant would be billed by the landlord for both the utility charges and the solar generation. An additional security deposit would be required for either case. One solar administrator should suffice for a large number of homes, herein assumed to be 1,000, in a given territory.

The economics of combining solar electricity sales with single family home rentals were modeled for thirteen case studies in twelve state markets: (1) Phoenix, Arizona, (2) Riverside, California for two different utilities, (3) Connecticut, (4) Atlanta, Georgia, (5) Indianapolis, Indiana, (6) Maryland – various counties, (7) Massachusetts – various counties, (8) Las Vegas, Nevada, (9) New Jersey – various counties, (10) Nassau County, New York, (11) Charlotte, North Carolina, and (12) Nashville, Tennessee. In most cases, a market was defined by the state/city and the utility supplying electricity. For each market, a ten-year horizon analysis was run for a rental operation, a solar sales operation, and the combination of the two. All major financial, tax, and solar variables were modeled as detailed in the Appendices. In addition to the baseline scenario, each case study was also subjected to a sensitivity analysis involving declining solar costs and declining solar incentives.

Under the baseline scenarios, the two California studies and three Northeast cases – Massachusetts, New York, and New Jersey – produced after-tax solar-rental returns ranging from 0.08% below to 0.19% above rental-only returns, results that were deemed competitive. The California market is characterized, generally, by high electricity prices and high solar irradiance. In one of the cases, generous upfront solar incentives boosted returns by lowering PV system costs. In the other case, yields were maximized by displacing only the portion of grid electricity priced at the highest marginal rates. The Northeast markets are characterized by moderate solar irradiance, high electricity prices, and generally attractive performance-based SRECs. Under the reasonable scenario in which the installed cost of residential solar PV systems falls 20% from current $5 levels, Nevada and Maryland also become competitive solar-rental markets, making seven out of thirteen markets competitive. In fact, with 20% drops in solar costs, the Massachusetts and California – RPU results clearly dominate rental-only outcomes, by 0.36% and 0.43%, respectively. (New Jersey would join the ranks of superior solar-rental markets were it not for currently depressed SREC prices.) Importantly, these results do not account for the likely synergies of a combined operation, including PV system discounts and a reduced number of homes to be managed for a given investment base.

As solar panel prices and, especially, balance-of-system installation costs continue to decline in the face of rising electricity rates, solar energy-rentals offer a number of economic advantages to a pure rental approach that should prove attractive to large residential rental property investors in a growing number of state and utility markets. They also promise a substantial increase in home renewable energy use contingent upon the decisions of a relative few property owners.

Table 1. Operating Costs, Escalators, Taxes, & Other Assumptions

Rental Property	
Economic Losses (% of Gross Rent)	4%
Operating Expenses (% of Gross Rent)	42%
Capital Expenses (% of Gross Rent)	2.0%
Depreciation (yrs)	27.5
Solar PV System	
Maintenance Cost (annual % of cost)	0.5%[23]
Management Cost ($/home/1000 homes)	$100
Inverter Operating Life	10
Inverter Replacement Cost	$ 1,000[24]
System Life (yrs)	25
System Performance Degradation Factor (%/yr)	0.5%
Depreciation	5 yr MACRS
Escalators	
Rent	2.7%
Expense	2.6%
Home Price	2.25%
Electricity	3.50%
Taxes	
Income	35%
Depreciation Recapture	25%
Capital Gains	15%

[23] $100 minimum except for California – SCE case study, due to the smaller system size relative to the other cases.
[24] For California – SCE, $500 is assumed because of the smaller system size relative to the other cases.

Table 2a. Financial Analysis: Property Costs & Rents; PV System Costs & Revenues; Electricity Data & Solar Incentives

	Arizona	California	Connecticut	Georgia	Indiana
County	Maricopa	Riverside	Various	Fulton	Marion
City	Phoenix	Riverside	All	Atlanta	Indianapolis
Utility	APS, SRP	RPU	CLP, UIC	GP	IPL
Rental Property Costs & Rents					
Property Cost[25]	$200,000	$300,000	$260,000	$150,000	$200,000
Value of Land	$40,000	$60,000	$52,000	$30,000	$40,000
Initial Repairs	$20,000	$30,000	$26,000	$30,000	$20,000
# properties per solar installation	2	2	2	2	2
Depreciable Tax Basis	$180,000	$270,000	$234,000	$150,000	$180,000
Gross Rental Yield	12.5%	12.5%	12.5%	12.5%	12.5%
Gross Rent/month	$2,292	$3,438	$2,979	$1,875	$2,292
Solar PV System Costs & Revenues					
Installed Cost/Watt (pre-tax, incentives)	$5.00	$5.00	$5.00	$5.00	$5.00
System Size (kW)	5	6	5	5	5
Installed Cost (including taxes, rebates)	$23,000	$20,325	$25,000	$26,250	$21,875
Expected AC Output (kWh/month)	674	763	493	560	510
Expected AC Output (kWh/yr)	8,085.00	9,157.98	5,920.00	6,725.00	6,120.00
Expected Value of Generation/month	$ 75.26	$ 125.16	$ 85.25	$ 66.69	$ 42.43
Expected Value of Generation/yr	$ 903.09	$1,501.91	$ 1,022.98	$ 800.28	$ 509.18
Expected Value of SREC sales/yr	$0	$0	$0	$0	$0
Electricity Use & Price					
Average marginal cost/kWh	$ 0.11	$ 0.16	$ 0.17	$ 0.12	$ 0.08
Average demand/month (kWh)	1,159	900[26]	720	1,107	1,055
Avg. electricity bill (ex-fixed costs)	$ 129.46	$ 147.60	$ 124.42	$ 131.73	$ 87.82
Electricity Escalator	3.50%	3.50%	3.50%	3.50%	3.50%
State & Local Incentives					
SRECs	No	No	No	No	No
SREC Price (See Appendix 2)	$ -	$ -	$ -	$ -	$ -
Assumed Residual SREC Price (App. 2)	$ -	$ -	$ -	$ -	$ -
Tax SREC proceeds	Yes	Yes	Yes	Yes	Yes
Sales Tax Exemption	Yes	No	Yes	No	Equipment
Property Tax Exemption	Yes	Yes	Yes	No	Yes
State ITC (including caps)	$1,000	$0	$0	$0	$0
State Rebate	$0	$0	$0	$0	$0
Local/Utility Rebate	$2,000	$12,000	$0	$0	$4,000
Federal Incentives					
ITC	0%	0%	0%	0%	0%
Depreciation	5 yr MACRS	5 yr MACRS	5 yr MACRS	5 yr MACRS	5 yr MACRS

[25] Based on number of homes per solar installation. See 3 fields below.
[26] Monthly usage based on conversation with senior account manager of Riverside Public Utilities.

Table 2b. Financial Analysis (cont'd): Cash Flow Returns

	Arizona	California	Connecticut	Georgia	Indiana
County	Maricopa	Riverside	Various	Fulton	Marion
City	Phoenix	Riverside	All	Atlanta	Indianapolis
Utility	APS,SRP	RPU	CLP, UIC	GP	IPL
Debt	50%	50%	50%	50%	50%
Equity	50%	50%	50%	50%	50%
Borrowing Cost	5.00%	5.00%	5.00%	5.00%	5.00%
Term (yrs)	10	10	10	10	10
Average marginal cost/kWh	$ 0.11	$ 0.16	$ 0.17	$ 0.12	$ 0.08
SRECs ($/kWh; $0 = not offered)	$ -	$ -	$ -	$ -	$ -
Rebates (State and Local/Utility)	$2,000	$12,000[27]	$0	$0	$4,000
Pre-tax Solar Revenues	$ 903.09	$1,501.91	$ 1,022.98	$ 800.28	$ 509.18
Rental Returns:					
Average Capitalization Rate (unlevered)	7.38%	7.38%	7.38%	7.38%	7.38%
Pre-tax Cash Flow Yield	9.79%	9.79%	9.79%	8.91%	9.79%
After-tax Cash Flow Yield	7.61%	7.61%	7.61%	6.77%	7.61%
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	7.61%	7.61%	7.61%	6.77%	7.61%
Solar Returns:					
Average Capitalization Rate (unlevered)	2.92%	6.50%	3.23%	2.11%	1.03%
Pre-tax Cash Flow Yield	-4.01%	9.47%	-2.79%	-9.33%	NM
After-tax Cash Flow Yield	-4.01%	8.44%	-2.79%	-9.33%	NM
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	1.77%	12.76%	2.82%	-3.07%	-10.30%
Combined Solar + Rental Returns:					
Average Capitalization Rate (unlevered)	6.95%	7.33%	7.04%	6.70%	6.80%
Pre-tax Cash Flow Yield	8.77%	9.77%	8.98%	7.24%	8.34%
After-tax Cash Flow Yield	7.04%	7.76%	7.18%	5.73%	6.70%
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	7.10%	7.79%	7.23%	5.94%	6.78%

[27] Program set to reopen July 2013 (City of Riverside, CA, 2012).

Table 3a. Financial Analysis: Property Costs & Rents; PV System Costs & Revenues; Electricity Data & Solar Incentives

	Maryland	Massachusetts	Nevada	New Jersey	New York
County	Various	Various	Clark	Various	Nassau
City	All	All	Las Vegas	All	All
Utility	BGE	NSTAR	NV Energy	PSEG, JCPL	LIPA
Rental Property Costs & Rents					
Property Cost[28]	$340,000	$400,000	$200,000	$260,000	$400,000
Value of Land	$68,000	$80,000	$40,000	$52,000	$80,000
Initial Repairs	$34,000	$40,000	$20,000	$26,000	$40,000
# properties per solar installation	2	2	2	2	2
Depreciable Tax Basis	$306,000	$360,000	$180,000	$234,000	$360,000
Gross Rental Yield	12.5%	12.5%	12.5%	12.5%	12.5%
Gross Rent/month	$3,896	$4,583	$2,292	$2,979	$4,583
Solar PV System Costs & Revenues					
Installed Cost/Watt (pre-tax, incentives)	$5.00	$5.00	$5.00	$5.00	$5.00
System Size (kW)	5	5	6	5	5
Installed Cost (including taxes, rebates)	$24,750	$24,563	$24,330	$25,875	$16,250
Expected AC Output (kWh/month)	503	500	832	507	499
Expected AC Output (kWh/yr)	6,030.00	6,005.00	9,981.00	6,084.00	5,990.00
Expected Value of Generation/month	$ 64.12	$ 76.21	$ 98.65	$ 81.68	$ 88.90
Expected Value of Generation/yr	$ 769.43	$ 914.56	$ 1,183.75	$ 980.13	$ 1,066.82
Expected Value of SREC sales/yr	$724	$1,321	$0	$1,016	$0
Electricity Use & Price					
Average marginal cost/kWh	$ 0.13	$ 0.15	$ 0.12	$ 0.16	$ 0.18
Average demand/month (kWh)	926	572	965	711	823
Avg. electricity bill (ex-fixed costs)	$ 118.16	$ 87.12	$ 114.45	$ 114.54	$ 146.58
Electricity Escalator	3.50%	3.50%	3.50%	3.50%	3.50%
State & Local Incentives					
SRECs	Yes	Yes	No	Yes	No
SREC Price (See Appendix 2)	$ 120	$ 220	$ -	$ 167	$ -
Assumed Residual SREC Price (See Appendix 2)	$ 50	$ 133	$ -	$ 133	$ -
Tax SREC proceeds	Yes	Yes	Yes	Yes	Yes
Sales Tax Exemption	Equipment	No	No	Equipment	Yes
Property Tax Exemption	Yes	Yes	Yes	Yes	Yes
State ITC (including caps)	$0	$1,000	$0	$0	$4,063
State Rebate	$1,000	$2,000	$8,100	$0	$0
Local/Utility Rebate	$0	$0	$0	$0	$8,750
Federal Incentives					
ITC	0%	0%	0%	0%	0%
Depreciation	5 yr MACRS	5 yr MACRS	5 yr MACRS	5 yr MACRS	5 yr MACRS

[28] Based on number of homes per solar installation. See 3 fields below.

Table 3b. Financial Analysis (cont'd): Cash Flow Returns

	Maryland	Massachusetts	Nevada	New Jersey	New York
County	Various	Various	Clark	Various	Nassau
City	All	All	Las Vegas	all	All
Utility	BGE	NSTAR	NV Energy	PSEG,JCPL	LIPA
Debt	50%	50%	50%	50%	50%
Equity	50%	50%	50%	50%	50%
Borrowing Cost	5.00%	5.00%	5.00%	5.00%	5.00%
Term	10	10	10	10	10
Average marginal cost/kWh	$ 0.13	$ 0.15	$ 0.12	$ 0.16	$ 0.18
SRECs ($/kWh; $0 = not offered)	$ 120	$ 220	$ -	$ 167	$ -
Rebates (State and Local/Utility)	$0[29]	$2,000[30]	$8,100[31]	$0	$8,750[32]
Pre-tax Solar Revenues	$ 769.43	$ 914.56	$ 1,183.75	$ 980.13	$ 1,066.82
Rental Returns:					
Average Capitalization Rate (unlevered)	7.38%	7.38%	7.38%	7.38%	7.38%
Pre-tax Cash Flow Yield	9.79%	9.79%	9.79%	9.79%	9.79%
After-tax Cash Flow Yield	7.61%	7.61%	7.61%	7.61%	7.61%
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	7.61%	7.61%	7.61%	7.61%	7.61%
Solar Returns:					
Average Capitalization Rate (unlevered)	4.97%	8.06%	3.95%	6.78%	5.27%
Pre-tax Cash Flow Yield	0.72%	11.19%	0.73%	4.88%	6.30%
After-tax Cash Flow Yield	0.72%	9.76%	0.73%	4.52%	5.82%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	5.73%	13.60%	5.99%	8.84%	10.58%
Combined Solar + Rental Returns:					
Average Capitalization Rate (unlevered)	7.23%	7.41%	7.03%	7.33%	7.30%
Pre-tax Cash Flow Yield	9.34%	9.86%	9.01%	9.45%	9.67%
After-tax Cash Flow Yield	7.41%	7.80%	7.24%	7.53%	7.62%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	7.45%	7.81%	7.30%	7.59%	7.62%

29 $1,000 flat rebate offered only when the property is the applicant's primary residence (DSIRE, 2012).
30 Current funding = $1.5MM → 750 homes at 5kW/home but program also covers commercial (DSIRE, 2012).
31 Program currently closed (NV Energy, 2012).
32 2012 budget is $26.3MM → 3,006 homes at 5kW/home but program also covers residential, commercial, gov't, schools, and non-profits (DSIRE, 2012).

Table 4a. Financial Analysis: Property Costs & Rents; PV System Costs & Revenues; Electricity Data & Solar Incentives

	North Carolina	**Tennessee**
County	Mecklenburg	Davidson
City	Charlotte	Nashville
Utility	Duke Energy	NES
Rental Property Costs & Rents		
Property Cost[33]	$150,000	$150,000
Value of Land	$30,000	$30,000
Initial Repairs	$30,000	$30,000
# properties per solar installation	2	2
Depreciable Tax Basis	$150,000	$150,000
Gross Rental Yield	12.5%	12.5%
Gross Rent/month	$1,875	$1,875
Solar PV System Costs & Revenues		
Installed Cost/Watt (pre-tax, incentives)	$5.00	$5.00
System Size (kW)	5	5
Installed Cost (including taxes, rebates)	$21,813	$26,313
Expected AC Output (kWh/month)	549	549
Expected AC Output (kWh/yr)	6,590.00	6,590.00
Expected Value of Generation/month	$ 45.31	$ 52.01
Expected Value of Generation/yr	$ 543.68	$ 624.07
Expected Value of SREC sales/yr	$ 0	$593
Electricity Use & Price		
Average marginal cost/kWh	$ 0.08	$ 0.09
Average demand/month (kWh)	1,117	1,278
Avg. electricity bill (ex-fixed costs)	$ 92.15	$ 121.03
Electricity Escalator	3.50%	3.50%
State & Local Incentives		
SRECs	No	Yes[34]
SREC Price (See Appendix 2)	$ -	$ 90
Assumed Residual SREC Price (See Appendix 2)	$ -	$ -
Tax SREC proceeds	Yes	Yes
Sales Tax Exemption	No	No
Property Tax Exemption	Yes	Yes
State ITC (including caps)	$7,634	$0
State Rebate	$0	$0
Local/Utility Rebate	$5,000	$1,000
Federal Incentives		
ITC	0%	0%
Depreciation	5 yr MACRS	5 yr MACRS

[33] Based on number of homes per solar installation. See 3 fields below.
[34] Tennessee has a Feed-in Tariff program that pays a premium over retail rates for each kWh of solar generation.

Table 4b. Financial Analysis (cont'd): Cash Flow Returns

	North Carolina	Tennessee
County	Mecklenburg	Davidson
City	Charlotte	Nashville
Utility	Duke Energy	NES
Debt	50%	50%
Equity	50%	50%
Borrowing Cost	5.00%	5.00%
Term	10	10
Average marginal cost/kWh	$ 0.08	$ 0.09
SRECs ($/kWh; $0 = not offered)	$ -	$ 90
Rebates (State and Local/Utility)	$5,000	$1,000
Pre-tax Solar Revenues	$ 543.68	$ 624.07
Rental Returns:		
Average Capitalization Rate (unlevered)	7.38%	7.38%
Pre-tax Cash Flow Yield	8.91%	8.91%
After-tax Cash Flow Yield	6.77%	6.77%
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	6.77%	6.77%
Solar Returns:		
Average Capitalization Rate (unlevered)	1.21%	3.56%
Pre-tax Cash Flow Yield	NM	-10.06%
After-tax Cash Flow Yield	NM	-10.06%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	-8.53%	-4.25%
Combined Solar + Rental Returns:		
Average Capitalization Rate (unlevered)	6.70%	6.88%
Pre-tax Cash Flow Yield	7.24%	7.35%
After-tax Cash Flow Yield	5.71%	5.80%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	5.82%	5.94%

Table 5a. Financial Analysis: Property Costs & Rents; PV System Costs & Revenues; Electricity Data & Solar Incentives

	California	**California**
County	Riverside	Riverside
City	Riverside	Riverside
Utility	SCE	RPU
Rental Property Costs & Rents		
Property Cost (based on # properties below)	$300,000	$300,000
Value of Land	$60,000	$60,000
Initial Repairs	$30,000	$30,000
# properties per solar installation	2	2
Depreciable Tax Basis	$270,000	$270,000
Gross Rental Yield	12.5%	12.5%
Gross Rent/month	$3,438	$3,438
Solar PV System Costs & Revenues		
Installed Cost/Watt (pre-tax, incentives)	$5.00	$5.00
System Size (kW)	2.5	6
Installed Cost (including taxes, rebates)	$12,969	$20,325
Expected AC Output (kWh/month)	318	763
Expected AC Output (kWh/yr)	3815	9,157.98
Expected Value of Generation/month	$ 66.78	$ 125.16
Expected Value of Generation/yr	$801.32	$1,501.91
Expected Value of SREC sales/yr	$0	$0
Electricity Use & Price		
Average marginal cost/kWh	$ 0.21	$ 0.16
Average demand/month (kWh)	618[35]	900[36]
Avg. electricity bill (ex-fixed costs)	$ 106.61[37]	$ 147.60
Electricity Escalator	3.50%	3.50%
State & Local Incentives		
SRECs	No	No
SREC Price (See Appendix 2)	$ -	$ -
Assumed Residual SREC Price (See Appendix 2)	$ -	$ -
Tax SREC proceeds	Yes	Yes
Sales Tax Exemption	No	No
Property Tax Exemption	Yes	Yes
State ITC (including caps)	$0	$0
State Rebate	$0	$0
Local/Utility Rebate	$500	$12,000
Federal Incentives		
ITC	0%	0%
Depreciation	5 yr MACRS	5 yr MACRS

[35] From the Clean Power Estimator at http://www.gosolarcalifornia.org/tools/clean_power_estimator.php.
[36] Monthly usage based on conversation with senior account manager of Riverside Public Utilities.
[37] Charges based on Southern California Edison's current Residential Rate Schedule D at http://www.sce.com.

Table 5b. Financial Analysis (cont'd): Cash Flow Returns

	California	California
County	Riverside	Riverside
City	Riverside	Riverside
Utility	SCE	RPU
Debt	50%	50%
Equity	50%	50%
Borrowing Cost	5.00%	5.00%
Term	10	10
Average marginal cost/kWh	$ 0.21	$ 0.16
SRECs ($/kWh; $0 = not offered)	$ -	$ -
Rebates (State and Local/Utility)	$500[38]	$12,000[39]
Pre-tax Solar Revenues	$801.32	$1,501.91
Rental Returns:		
Average Capitalization Rate (unlevered)	7.38%	7.38%
Pre-tax Cash Flow Yield	9.79%	9.79%
After-tax Cash Flow Yield	7.61%	7.61%
After-tax Cash Flow Yield (Assuming current-year utilization of all depreciation allowances)	7.61%	7.61%
Solar Returns:		
Average Capitalization Rate (unlevered)	5.22%	6.50%
Pre-tax Cash Flow Yield	5.65%	9.47%
After-tax Cash Flow Yield	5.23%	8.44%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	9.98%	12.76%
Combined Solar + Rental Returns:		
Average Capitalization Rate (unlevered)	7.30%	7.33%
Pre-tax Cash Flow Yield	9.64%	9.77%
After-tax Cash Flow Yield	7.60%	7.76%
After-tax Cash Flow Yield (Assuming current-year utilization of all ITCs, depreciation allowances)	7.60%	7.79%

[38] Based on current California Solar Initiative Rebate levels at http://www.csi-trigger.com/.
[39] Program set to reopen July 2013 (City of Riverside, CA, 2012).

Table 6. Sensitivity Analysis of After-tax Cash Flow Yields: Rental vs. Combined Solar + Rental

		Rental		Solar + Rental			
			Solar System Price →	Current	-20%	Current	-20%
State	City/County - Utility		Solar Incentives →	Current	Current	-25%	-25%
Arizona	Phoenix	7.61%		7.04%	7.35%	7.01%	7.32%
California	Riverside - RPU	7.61%		7.76%	8.04%	7.64%	7.92%
California	Riverside - SCE	7.61%		7.60%	7.72%	7.59%	7.71%
Connecticut	Various counties	7.61%		7.18%	7.42%	7.18%	7.42%
Georgia	Atlanta	6.77%		5.73%	6.13%	5.73%	6.13%
Indiana	Indianapolis	7.61%		6.70%	7.02%	6.64%	6.96%
Maryland	Various counties	7.61%		7.41%	7.60%	7.34%	7.52%
Massachusetts	Various counties	7.61%		7.80%	7.97%	7.66%	7.83%
Nevada	Las Vegas	7.61%		7.24%	7.65%	7.12%	7.52%
New Jersey	Various counties	7.61%		7.53%	7.77%	7.42%	7.67%
New York	Nassau County	7.61%		7.62%	7.78%	7.55%	7.71%
North Carolina	Charlotte	6.77%		5.71%	6.12%	5.62%	6.03%
Tennessee	Nashville	6.77%		5.80%	6.22%	5.71%	6.12%

Table 7. Southern California Edison (SCE) Residential Rate Schedule D (Filing Date: 12/31/2012)

Schedule D	Baseline Region 10[40]						
Rates/kWh as of	12/31/2012			130%[41]	200%	300%	10000%
	Summer	0	480[42]	624	960	1440	48000
		$	0.1295	$ 0.1607	$ 0.2938	$ 0.3288	$ 0.3638
	Winter	0	315	409.5	630	945	31500
		$	0.1295	$ 0.1607	$ 0.2938	$ 0.3288	$ 0.3638
	Tier	0	1	2	3	4	5

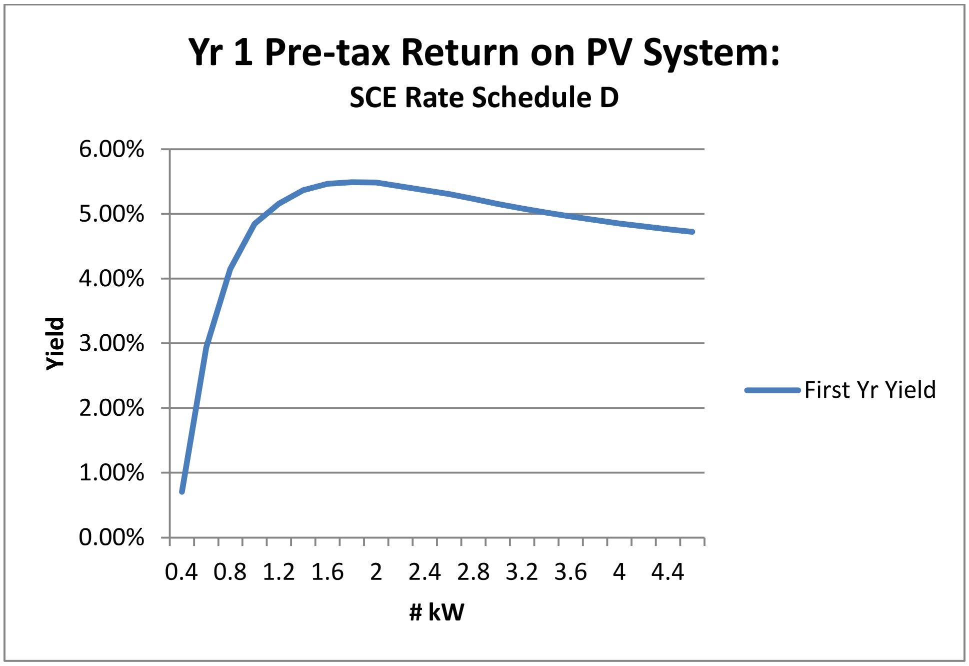
http://www.sce.com

Table 8. Typical electricity demand profile for a home in Riverside, California with a $100/month bill[43]

Month	Season	Average On-Peak Demand/month (kWh)	Average Off-Peak Demand/month (kWh)
January	Winter	170	512
February	Winter	124	388
March	Winter	139	441
April	Winter	131	405
May	Winter	136	415
June	Summer	164	446
July	Summer	209	539
August	Summer	191	511
September	Summer	166	452
October	Winter	149	440
November	Winter	146	448
December	Winter	175	521
		Yearly Demand	7,419
		Avg. Demand/month	618

[40] Riverside is in baseline region 10
[41] Percent of baseline for the rate tier
[42] Summer baseline for region 10
[43] From the Clean Power Estimator at http://www.gosolarcalifornia.org/tools/clean_power_estimator.php.

Figure 5. Efficiency curve for sizing a PV system in a region with high-cost marginal electricity rate tiers



Based on a home in Riverside, California with a monthly electric bill of approximately $100. Utility: Southern California Edison. Rate Schedule: Residential Schedule D (Table 7 above). Data for electricity demand derived from the Clean Power Estimator at http://www.gosolarcalifornia.org/tools/clean_power_estimator.php. Assumes constant fixed costs and variable operating and maintenance expenses based on system size, subject to a minimum.

Appendix 1. Principal Inputs to the Distressed Rental Model

The following are brief explanations of major variables used for the modeling of the single family rental operation.

Home Prices

Distressed home prices for the locations of the study represent rounded approximations from several sources: (1) Zillow.com, which was used to sample foreclosure prices in specific cities/zip codes; (2) RealtyTrac.com's Stats & Trends section, which lists, by state, county, and even city, average foreclosure sales prices; (3) Grant's Interest Rate Observer, which featured an in-depth article on the trend of institutional buying of distressed properties for rental and later resale purposes (Grant, 2012); and (4) Various news articles highlighting or inferring purchase costs in the distressed housing market.[44]

Land Values

Land values were assumed to be 20% of the purchase price. This figure affects depreciation since only the house value is depreciated for tax purposes.

Initial Repairs

Initial capitalized repair/renovation costs mentioned in several articles ranged from $10,000-$30,000. The model simply assumed a ratio of 10% of the purchase price. Since most homes in the study were priced from $100,000-$200,000, this would produce $10,000-$20,000 of capitalized repairs.

Rental Yields

Gross rental yields[45] were inferred from several articles on the distressed rental markets and from reported transactions by institutional property managers (Grant, 2012) (Chang & Tirupattur, October 27, 2011) (Arixa Capital Advisors, LLC, 2012). While yields as high as 15% were claimed in 2012, rates have been falling due to competition among institutional investors for homes. According to one report, net unlevered yields are expected to fall from a recent 7% to 5.5%, a level consistent with the REIT market (Yu & Kelly, 2012). The analysis assumed a 12.5% gross yield to capture a blend of the initial distressed home prices and more recent levels. Net first-year yields, after operating expenses described below, will be about 6.50% as a result and should be consistent with portfolio averages after accounting for rising purchase prices.

Rent Escalator

Rent growth averaged 2.7% annually since 2009 and some metropolitan areas experienced even higher rates (Marcus & Millichap Real Estate Investment Services, 2012). As examples of differing opinions on future rent increases, the Congressional Budget Office refers to an expected inflation rate of 2.2% in the coming decade while a report from the University of Southern

[44] (Mattson - Teig, 2012) (Perlberg & Gittelsohn, 2013) (Yu & Kelly, 2012)
[45] Gross Rental Yield (GRY) = [Gross Rent – Operating Expenses] / Capitalized Cost of Property

California and Casden forecasts a 3.8% aggregate rise in rents during 2012 and 2013, albeit for multifamily rentals (Ozanne, 2012) (Green, Seslen, & Tirsbier, 2012).

The model assumed a 2.7% rent escalator over the horizon of the analysis. This reflects the annual change in rents indicated by the Consumer Price Index for all urban consumers for the period 2004-September 2012 (CPI-U, Table 26) (BLS, 2012). Clearly, a year or two of faster rent escalation may be possible due to rising demand and lower vacancies. However, over the horizon of the study, one would expect a reversion to the mean.

Operating Expenses, Losses

Managing hundreds or thousands of individual homes in diverse geographic regions is a relatively new enterprise and thus, long-term operating expense data is sparse. Consequently, results from both the apartment sector and several studies of (non-institutional) single family rentals were used in tandem to estimate operating expenses for the analysis. The model used two categories to capture rental costs: economic losses from vacancies, collection fees, and rent concessions; and general operating expenses that include salaries, insurance, taxes, utilities, management fees, marketing, administrative, and others.

Losses from Vacancy, Collection, and Concessions (VCC)

A report from the National Apartment Association (NAA) indicates about 12% for VCC for apartments (Lee, 2012). An analysis by Morgan Stanley on the single family rental market assumes an 8% vacancy rate (Chang & Tirupattur, October 27, 2011). One real estate investment firm managing single family rentals cited studies indicating that single family tenants are more likely to be families that stay, on average, for two to three years (Brzeski & Hebner, 2012) (Brzeski J. B., 2012). This would imply that VCC losses would be approximately halved from apartment levels. Interestingly, Waypoint, one of the private equity buyers in the rental market, is seeking 2-year leases, a strategy that may reduce vacancy and collection rates below the average levels mentioned above (Neumann, 2012).

The model assumed VCC losses of 4% of gross rent, a result of the combination of data from the studies mentioned above indicating average lease terms for single family tenants of just over two years, and the expected tight supply and high demand for housing in the target locations. The latter should both reduce the need for concessions and lengthen the average tenancy.

General Operating Expenses

The report on the single family rental market by Morgan Stanley suggests close to a 50% net operating income (NOI) ratio. This would imply a 42% operating expense rate after allowing for the 8% vacancy rate above (Chang & Tirupattur, October 27, 2011) (See p. 8, Scenario 2, LTV 0, Capital Appreciation 0% vs. Gross Rent.). The NAA report indicates a 42% rate as well, while two papers from one of the property managers present scenarios suggesting a 35%-45%

ratio. Finally, examples given in some of the articles discussing gross and net yields on distressed rentals also imply expenses in the low- to mid-40% range (Grant, 2012). Therefore, the analysis assumed an expense ratio of 42% of gross rent.

Capital Expenses

It is assumed that most capital expenses will be captured by upfront capex for repairs/renovations in prepping the home for occupancy. The model budgeted a nominal 2% of annual gross rent to anticipate one or two additional repairs during the investment period.

Expense Escalator

Operating expenses were assumed to track the overall Consumer Price Index. The CPI-U increased 2.6% per year from Dec 2003 – Dec 2011 (CPI-U, Table 26) (BLS, 2012).

Depreciation

Homes were depreciated on a straight line basis over 27.5 years as per standard tax accounting for residential rental property (IRS 527).

Taxes

The model assumed a 35% marginal income tax rate since this market consists mostly of high net worth investors and institutions. Capital gains (at sale) were taxed at 15%. The calculations accounted for MACRS depreciation (for capital expenditures), acceleration of any unused net operating loss carryforwards at the time of sale, and depreciation recapture, which is subject to a 25% tax rate. The latter occurs when the sales price of the asset exceeds the (depreciated) book value of the asset. Depreciation is "recaptured" up to the point of the original basis. Beyond that, proceeds are considered ordinary capital gains.

Home Price Escalator

Private equity investors in the distressed rental market anticipate capturing the initial "distressed" discount and general price appreciation during their investment period. Distressed discounts have been quoted at 30-50% (Mattson - Teig, 2012) (Khater, 2012). The model assumed that over the horizon of the analysis only the discount is recovered and the discount is only 20% to allow for the recent price increases resulting from competition among institutional buyers and others.

As an aside, apparently, the distressed discount has all but disappeared in Phoenix (Perlberg H. , 2012).

Debt

As of early May, 2013, 15-year mortgage rates for owner-occupied properties are about 2.75% while 5-year ARM rates are at 2.63% (da Costa, 2013). Most apartment REITs are yielding 3% - 4%. Surveys of investment property financing rates on Zillow.com generated responses of 4%-4.5% for 20-30 year loans. Several credit union websites indicated 3% to 4%+ rates on investment property loans ranging from 5-year ARMs to 20-30 year fixed.[46] According to Fidelity.com, the average debt-to-capital ratio for Real Estate Investment Trusts (REITs) is approximately 56% (Fidelity.com, 2013). Considering these findings, the model assumed a 50% debt-to-capital ratio and 5% borrowing rate to be somewhat conservative.

[46] (Digital Federal Credit Union, 2013) (Boston Firefighters Credit Union, 2013) (San Mateo Credit Union, 2013)

Appendix 2: Principal Inputs to the Solar Energy Sales Operation

The following are brief explanations of major variables used for the modeling of the solar energy sales operation.

The Rental Home/Solar PV Installation Ratio

Availability of individual homes for rooftop solar systems is based on several factors, including orientation, shading, space, etc. In a report from the National Renewable Energy Laboratory on potential supply curves of U.S. electricity from rooftops, the average estimate of availability for Southwestern states was 60% while for the remaining states it was 37.5% (Denholm & Margolis, 2008). In view of those figures, the approximate average of 50% was used for this study. Therefore, the model assumed that one solar PV system will be installed for every two rental homes.

DC to AC-output Derating Calculations

The so-called nameplate power rating of solar panels is expressed in direct current (DC) terms. There is a loss of power as the incoming sunlight is converted to the standard alternating current (AC) of the grid. The loss is due to a number of factors, e.g., wire resistance, inverter efficiency, soiling of the panels, etc. A derate factor is normally calculated to express the expected output as a percentage of nameplate DC power rating. The model assumed the implicit derating factor of the National Renewable Energy Laboratory's (NREL) PVWatts Calculator of .77 (NREL, 2012).

Expected Power Output (AC) per kW of Installed Solar Panels in Each Market

The model used both versions of NREL's PVWatts Viewer application to derive expected electricity generation in each of the studied markets. PVWatts Viewer uses solar insolation in each region and the derating factor from above, among other inputs, to calculate the results. See the links below:
Version 1: Uses site specific data for a limited number of locations per state.
http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/
Version 2: Uses 40km grid cells that generally allow users to specify actual addresses/zip codes/cities. http://gisatnrel.nrel.gov/PVWatts_Viewer/index.html

Operating & Maintenance Cost

Most websites claim that solar panels may need a yearly or periodic washing to clean dust, droppings, etc. to maintain peak efficacy. The analysis assumed 0.5% of cost, with a $100 minimum, for operating & maintenance (O&M), a figure cited in industry studies (Bony, Doig, Hart, Maurer, & Newman, 2010). Given that most systems in this analysis will be sized at 5-6 kW, this value should correspond to the cost of a roof cleaning service.[47]

Note: An insurance market has developed for PV systems, but it is still immature. Premiums are estimated at 0.25% to 0.5% of system costs/yr or more, for residential systems (Speer, Mendelsohn, & Cory, 2010). The analysis did not consider insurance. That being said, inverters usually have manufacturer warranties of up to ten years and panels usually have several-year warranties as well.

Management Expense

In general, existing rental operation management should be able to carry out most ongoing administration of the solar operation once the systems are installed. Responsibilities include monthly meter reading - which should be done remotely using smart meters - billing, arranging service calls for the occasional cleaning/maintenance, and, in SREC markets, registering and selling the SRECs through online marketplaces or auctions. The analysis assumes that one extra head count per 1,000 homes should suffice as overall manager/supervisor of solar operations. At a salary of $100K/year, this equates to $100/home of additional annual expenses.

Inverter Cost

Factory gate inverter pricing in Q2 2012 was quoted at $0.23/W (SEIA & GTM Research, 2012). A search of websites indicates prices from $1000-$2000 for 5000W inverters. The assumption is that in 10 years, when today's inverter needs replacing, prices will have dropped significantly. $1000 was assumed for the analysis for systems of 5-6 kW. $500 was assumed for systems of 2.5kW.

Inverter Replacement Cycle

10 years was assumed for the service life of a grid-tied inverter for a PV system. This is consistent with online references to warranties of 10 years. See, for example, http://us.sunpowercorp.com/support/warranty/

Solar Panel Degradation

There is a slow degradation of solar panel performance over time. According to researchers, the median degradation factor is approximately .5%/yr (Jordan, Smith, Osterwald, Gelak, & Kurtz, 2010) (Zweibel, 2009). The model accounted for this in its time calculations of power output and in calculating the residual value of the system at the time of sale.

[47] The Riverside – SCE case study costs were scaled for the significantly smaller system, but still 0.5% of the system cost.

Electricity Rates

Power from a rooftop solar PV system should be valued at the marginal price of grid-supplied electricity from the local utility. Fixed charges, such as monthly customer service fees, would still be incurred by the homeowner and should not factor into the analysis. For most cases, the model used residential retail electric rates from the Energy Information Administration's Electric Sales, Revenue, and Average Price Table for the Residential Sector (EIA, 2011). The data were typically from a large investor-owned utility – such as NV Energy of Nevada – or were from a municipal utility servicing a specific city/region, e.g., Riverside Public Utilities of Riverside, California. In one case – Southern California Edison (SCE) – a recently filed residential rate schedule was used in order to model its higher-cost marginal price tiers.

Electricity Inflation

To develop an estimate for future electricity rate increases, several sources were referenced. Compounded Consumer Price Index data for electricity were calculated using December-to-December changes from 2004-2011, plus the December 2011-September 2012 change for all urban consumers (CPI-U, Table 26) (BLS, 2012). The calculated compounded rate was approximately 4.5%. However, over just the last 3-4 years, electricity prices have been increasing at closer to 2-2.5%, probably due to the use of cheap natural gas as feedstock, and are projected to grow at a 0.3% rate for the overall nation through 2035 (EIA, 2013). Ultimately, rate increases are likely to be specific to each region. For example, electricity prices in the Los Angeles-Riverside-Orange County, California Consolidated Metropolitan Statistical Area (CMSA), including Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties in California, rose 13.7% from March 2012 to March 2013 while overall U.S. electricity rates were flat (BLS, 2013). This CMSA is one of the regions with favorable results for the solar-rental model. Given these differences, the analysis assumed 3.5%, as an approximate middle ground between past rates and the forecast levels.

Residual Value of PV System at Horizon Date

At the horizon date of the analysis – 10 years – both the home and the rooftop solar PV system are assumed to be sold. The model calculated a residual PV system value based on the present value of energy generation over the remaining system life plus the present value of projected future SREC sales for relevant markets. (See below.) The solar panel systems were assumed to have a 25-year service life, which is conservative by most accounts. The present value of residual energy generation included system degradation, electricity inflation, and discounting at the borrowing rate. Using this approach, values were consistent with lower-end findings from the California hedonic study of the effects of PV systems on home prices (Hoen, Wiser, Cappers, & Thayer, 2011). That study reported a range of \$3.9 to \$6.4 per installed watt (DC). As examples from the present analysis, the (Riverside) California residual value was \$4.36/W while the New Jersey value was \$3.42/W. Most of the difference between these two values is due to the difference in solar insolation between these two locations. New Jersey's insolation is approximately 80% of the Southern California level. The hedonic study focused solely on California, but we would expect to see this insolation difference factor into New Jersey price premiums for homes with PV systems.

Rebates, SRECs, Tax Incentives, Net Metering Policies, Third-party PPA policies, etc.

All financial incentives and renewable energy policies were sourced from the Database of State Incentives for Renewables and Efficiency (DSIRE, 2012). This comprehensive database contains up-to-date information on all programs and policies across the U.S. It is funded by the U.S. Department of Energy and is jointly managed by the North Carolina Solar Center and the Interstate Renewable Energy Council, Inc. Where more clarity was needed on a specific incentive/policy, a link was usually provided in DSIRE to a specific state or utility website. For California's utility rebates, and specifically for SCE, the analysis assumed the next lowest level under the EPBB schedule given impending satisfaction of current-level quotas (CSI, 2013).

Solar Renewable Energy Certificates (SRECs)

For states with SREC programs, prices and eligibility period rules were sourced from DSIRE and SRECTrade, an online broker and auction house for SREC trading (DSIRE, 2012) (SRECTrade, 2013). (See the discussion of SRECs under the Examination of Incentives and Policies above.)

As a conservative measure for SREC pricing, the model assumed 50% of the average SACP for the 10-year period 2013-2022 for each relevant state. Since SACP levels decline over time, current values are therefore underweighted for an added measure of safety. This anticipates the periodic oversupply of SRECs when PV generation exceeds RPS requirements, a condition that currently exists in states such as New Jersey and Massachusetts due to falling system prices, RPS, and SACP levels that have incentivized overdevelopment in the last several years.[48] Residual pricing, for the period from the horizon date to the earlier of (i) the remaining system life and (ii) the SREC eligibility period, was calculated using 50% of SACP levels beyond 2022. If a floor price has been mandated, e.g., in Massachusetts, then the SREC price used was 50% of the floor price. SACP schedules were sourced from SRECtrade.com (SRECTrade, 2013).

Depreciation Rules

Solar PV systems are accorded accelerated depreciation by the IRS. 5-year MACRS depreciation was used in the analysis (Hagen, 2009) (IRS 946). This also required modeling of depreciation recapture at the time of sale. Any excess of the sales price of the house + PV system over the book value of the combined asset, up to the original cost basis, was taxed at the recapture gains rate of 25%. Any excess above the original cost basis was taxed at the regular 15% capital gains rate.

[48] For example, the average SACP for 2013-2022 for New Jersey is $333. Thus, the model assumed $167. Weighted average trade prices for SRECs for Jan-Mar 2013 have been close to $200. Source: www.njcleanenergy.com

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